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THE NEW ZEALAND GEOGRAPHER

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New Zealand Geographer

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THE CHANGING AGRICULTURAL ECONOMY OF FIJI

CEDRIC HARVEY

THE GENERAL course of agricultural development in Fiji has probably been little different from that of other tropical islands in which an indigenous population maintained a self-sufficient economy prior to the advent of western culture with its disruptive social and economic pressures.

In Fiji three periods of development may be recognised: (1) the early trading period when wild and cultivated products were purchased or bartered from the inhabitants by visiting or locally-established traders; (2) the plantation period during which the large-scale production of export crops was organised on land acquired from the inhabitants and worked to an increasing extent by immigrant labour; and (3) the farming period—still in process of development—characterised by the growth of small-farm settlements and accompanied by a discontinuous tendency towards the break-up of large plantations.

Population

Interwoven with this general pattern of development are the varying fortunes of the three principal racial groups of the colony: the Fijian indigenes numbering (in 1946) 117,488, the descendants of East Indian indentured labourers numbering 120,063, and the Europeans (including part-Europeans) 10,736. These last, though small in numbers, are important because of their dominating influence in the sphere of agriculture and commerce. From the impact of an alien trade economy during the first half of the nineteenth century down almost to the first world war, the Fijians suffered virtual eclipse as an active element in the economic development of Fiji. Tragic losses in population from the ravages of introduced disease, commencing with the measles epidemic of the year of cession, 1874, and the loss of large tracts of the most fertile land through transactions the real nature of which was foreign to their experience, led to an apathy from which it has taken them over half a century to recover. Not only did the Fijians dispose of

400,000 acres of land before further sales were stopped but, themselves disinclined to submit to the discipline of plantation employment, they were supplanted on the land by imported labourers, first Melanesian and then, more importantly, East Indian.

Not until 1906 was the decline in population arrested after which, except for a further fall in 1918, their numbers have steadily increased to overtake, in 1946, the first official census total of 114,000 in 1881. Accompanying this recovery in numbers has been a return of hope and purpose; this has resulted partly from social adjustments and sympathetic political and cultural encouragement; but since the second World War particularly, there has been an increasing confidence which has become manifest in a desire to participate more actively in the economic life of Fiji and to share the benefits of prosperity.

Terrain

The Colony of Fiji comprises about 250 islands of various sizes, of which about eighty are inhabited, with a total area of 7,083 square miles. The two main islands of Viti Levu and Vanua Levu account for 6,181 square miles. The interiors of both of the main islands, approximately five-sevenths of the total area, are rugged and mountainous and largely forest-covered, but in the drier zones areas of reed and grass occur, some of which are suitable for rough grazing. There are four general classes of agricultural land in use: the broad flood plains of the larger rivers where the soils are generally rich but often of impeded drainage, supporting sugar cane, rice and dairying; the narrower coastal fringes, which on the second largest and smaller islands especially are mostly given over to coconuts and native food crops; the narrow valleys of the upper courses of the river systems where bananas and food crops are grown; and the rolling or broken hill country below the higher ranges, originally under reed or forest, which affords rough grazing and supports a limited and precarious cropping. Of a total acreage of 4,581,000 it is estimated that not more than 1,300,000 acres are capable of agricultural development and of this 434,799 acres are held by fee simple and 480,000 acres under lease.

Early Trading Period

The earliest trading contacts with Fiji took place at the opening of the nineteenth century when sandalwood and bêche-de-mer were sought after. Settlement did not develop until after 1860, but by this

time many wild or native-grown products were exported. Early trade records are sparse, but in 1879 and 1880 the following exports were listed: arrowroot, Tonga bark, candlenuts, rattan canes, coir, tree fungus, ivory nuts, coconut oil, tapa, beeswax, yams and yanggona (kava). Most of these would have been native products, but in addition there were plantation products such as beans, coffee (£7,000), copra (native and plantation, £109,000), cotton (£45,000), cottonseed, dried fruit, bananas (£5,000), ginger, Angora goat hair, wool, hides, lime juice, peanuts, sugar (£26,000) molasses and rum, pepper and tobacco.

Large-scale Production

The earliest plantation enterprise was associated with cotton, interest having been aroused by enhanced prices as a result of the American Civil War. The boom was of short duration, but planters turned their attention to coconuts, coffee, cacao, sugar, bananas, vanilla, maize, sheep and cattle. The cession of the islands to the British Crown further encouraged the development of plantations but the early settlers had little planting experience and there were many failures. Horne, writing in 1880, records that they 'know next to nothing about the husbandry of the sugar cane, coffee, tea, cinchona, cacao and other products of the tropics. The consequence is that large sums are spent on worthless experiments or in working out useless theories, and not infrequently on fanciful and absurd notions. This want of practical knowledge among the settlers has been the ruin of Fiji from an agricultural point of view'. In 1892 the *Fiji Handbook* of that year commented that 'the majority of planters were hopelessly bankrupt at the date of the cession of the colony and for years subsequently they carried on from hand to mouth on money borrowed at ten percent interest in the hope—which had no practical foundation—that in some unforeseen way matters would improve, or were "holding on" for the benefit of their mortgages'.

The Sugar Cane Industry

However, the 'worthless experiments' served their purpose, whatever the cost to the individuals concerned, and development followed the natural law that capital and labour will divert themselves to those enterprises that yield the highest return. Thus as early as 1892 the principal agricultural exports were copra, sugar and green fruit (bananas) which was the position in 1948, except that sugar then took first

place. Sugar was found to grow remarkably well and from the time of its introduction in the early 'seventies it spread from Suva and the Rewa River to the coastal districts of Viti Levu, finally assuming its present distribution which includes almost the whole of the dry zone coastal area of Viti Levu with one mill in the wet zone of the same

TABLE I

SUGAR EXPORTS OF FIJI (*in £ Fiji*)

Year	Value of sugar exports
1875	£3,417
1890	£244,655
1910	£669,432
1920	£2,092,990
1930	£853,833
1940	£1,285,191
1947	£2,840,307

island, and another serving the dry zone of Vanua Levu. The later development of the sugar industry is illustrated in Table I.

LABOUR

The demand for labour for the new industry was so insistent that it could not be met from local resources. The Fijians were at this time in the early stages of their struggle for survival against the ravages of

TABLE II

COPRA EXPORTS OF FIJI (*in £ Fiji*)

Year	Value of copra exports
1875	£40,058
1890	£42,901
1910	£258,914
1920	£508,830
1930	£369,524
1940	£125,063
1947	£1,406,435*

*Includes value of coconut oil exported.

disease; moreover they were unaccustomed to the hard and regular labour of the cane plantations. Between 1860 and 1877 some 8,500 Melanesian labourers were introduced, but most were subsequently repatriated. In 1879 the first East Indian labourers were brought in

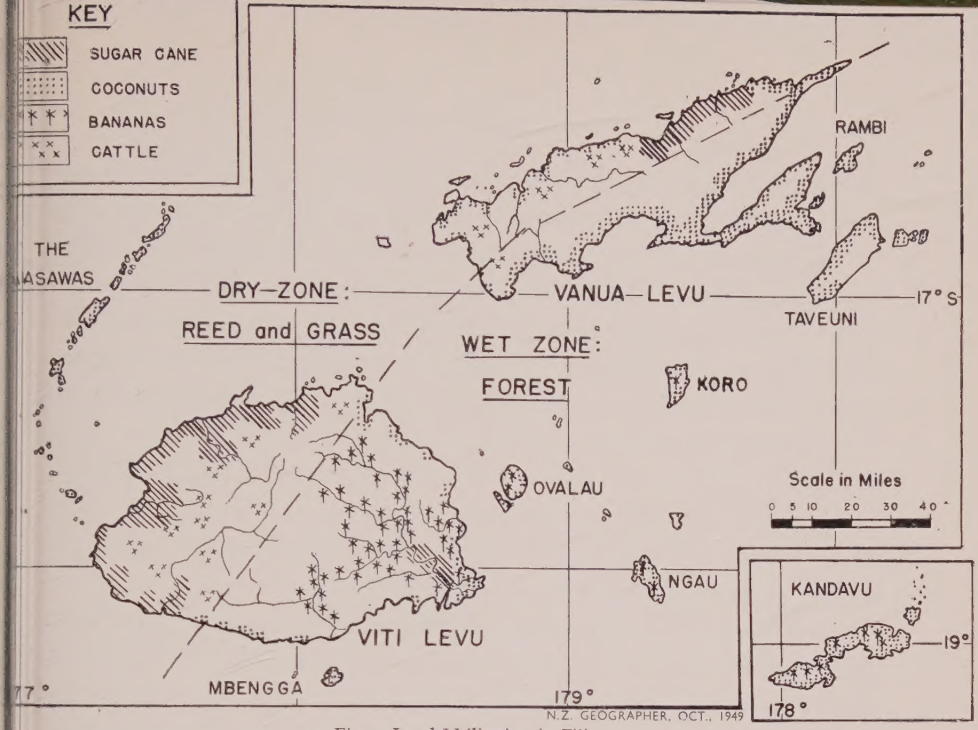

Fig. 1. Land Utilisation in Fiji.

under indenture and up to 1916, when the system was discontinued, over 60,000 had entered the colony, of whom less than half took advantage of their right to claim free passages to return to India. The industry was thus built almost exclusively from the labours of immigrant East Indians and the capital resources and experience of European plantation companies. In 1880 the Colonial Sugar Refining Co. Ltd. of Australia established interests in Fiji; it subsequently took over independent mills and since 1922 the milling of all cane produced has been in its hands.

Copra

The strong position of the sugar cane industry handicapped the development of other plantation enterprises which found great difficulty in competing for the inadequate labour supply. Early attempts to establish coffee, vanilla and cacao were abandoned, partly due to disease or storm damage, and only the copra industry could maintain and extend its position, though since the early years it has taken second place to sugar. Table II shows the steady increase in export values.

Geographically the copra industry has become established on the coastal fringes of Vanua Levu, the second largest island, and of the smaller islands. A number of factors have contributed to this: the concentration of sugar cane planting on Viti Levu and its competition for labour, the suitability for coconuts of coastal soils and climate

of the smaller islands, and the availability of Fijians for work on the estates. Work on coconut estates is more congenial to the Fijian; it proceeds generally at a slower tempo and there is not the compelling insistence of seasonal operations to be carried out to a timetable, and in consequence this industry has been developed and maintained largely by Fijian labour. Moreover for this industry no special cultivation equipment is required, nor capital assets other than land and the provision of food crops for subsistence; hence the Fijians have not only provided the greater part of the labour force required by the coconut estates, but they have themselves maintained and increased their own plantings so that Fijian-produced copra accounts for some sixty percent of the colony's total production at the present time.

As a tree crop of hardy nature the coconut does not suffer permanent harm from periods of neglect. That part of the industry for which the Fijians are themselves responsible possesses, for this reason, a particular resiliency; during periods of low prices the Fijian can afford to neglect his small holding or communal grove, to grow his food crops, and to rehabilitate his coconuts to bring them back to full production as the price improves. On the other hand the estate has overhead and capital costs to meet even in times of low prices. Moreover since the Fijian allows some fallen nuts to grow—many more in fact than he should—the Fijian grove is self-regenerating, with palms of all ages growing together, whereas the managed estate is maintained in orderly fashion, the palms progressing inexorably towards their maximum productive age of sixty to sixty-five years, after which production will fail unless systematic replanting is carried out. It is estimated that between one-third and one-half of the estates in Fiji will need to be replanted during the next twenty years if production is to be maintained.

Bananas

The third important plantation industry that survived the experimental period was the production of bananas for export to Australia and New Zealand. From early beginnings (£97 value in 1875) there was slow but steady expansion until the industry reached its heyday during the second decade of the present century, the peak being in 1917 when 1,653,639 bunches were shipped (for comparison, the equivalent of 260,000 bunches was shipped in 1947). A decline in productivity of plantations had become evident on account of pests and disease, probably associated also with a failure to maintain soil

fertility at the high level required by such a gross feeder as the banana plant. Moreover in the early 1920's the profitable Australian market was virtually closed by penal duties in order to protect the Queensland and New South Wales industries and New Zealand remained as the principal market. Severe competition for this market brought chaos to marketing arrangements, culminating in the introduction of the quota system in 1932 and the reduction of the trade to its present dimensions: £66,863 in 1935; £73,578 in 1938; £38,508 in 1943; £81,165 in 1947.

Period of Small Farm Settlement

Such was the position during the early years of the twentieth century. On the principal islands of Viti Levu and Vanua Levu the most fertile land in the dry zone, and on Viti Levu in the wet zone also, had been given over to sugar cane estates operated by immigrant East Indian labourers; on other fertile land in Viti Levu, mainly in the high rainfall areas, banana plantations were established. Meanwhile the Fijians had lost for ever some 400,000 acres of their best lands; the owners of land leased out as estates continued to draw their rents but they played little or no part in the production of sugar. As labourers and to some extent as independent producers they benefited from the early prosperity of the banana industry, but only in the coastal lands of the second and smaller islands, where coconut estates and native village plantations existed side by side, did they share to an appreciable extent the varying fortunes of an important industry.

However there were, at this time, already signs of a change towards a smaller unit of production. The decline in prosperity of the banana export industry through disease and loss of markets has been described. The estate production of fruit was discontinued; the land was given over to sugar cane, dairying or rice, but the production of bananas to satisfy the reduced export demand was taken over by the Fijians on their own lands and so became an important source of income to them. Although the marketing of the fruit has remained largely in European hands, under licence control by the government, Fijians produced 99.9 percent of the fruit exported in 1947 and there are some prospects of an expansion of the industry as shipping facilities improve.

A change of greater significance in the trend towards the small farm as the unit of production was becoming evident. Although the regular introduction of indentured East Indian labour enabled the

Fig. 2. Weeding and Mulching Dalo.

planting of sugar cane to be expanded, many of the labourers who reached the end of their term of indenture chose neither to return to India nor to continue as estate labourers; instead they sought and obtained land on lease from Fijians or other landowners, or purchased small blocks of freehold land, and established themselves as independent smallholders. They grew rice for subsistence and sale, tobacco, maize and pulses, and raised small numbers of goats and cattle, letting these graze at will on native land. This constant drain on the labour force obliged the sugar companies to depend on the annual influx of immigrant labourers. When this arrangement was terminated by the Government of India in 1916, and existing indentures were cancelled in 1920, a labour crisis arose which, together with a collapse of the sugar market, threatened the continued existence of the industry. The Colonial Sugar Refining Co. Ltd., which had farmed out much of its land to European planters, endeavoured for a while to carry on with Fijian labour, mechanising wherever possible, but at the same time it intensified its efforts to evolve a system of cane-growing by small farmers.

The reallocation of land amongst former labourers and independent farmers on the basis of a farm unit averaging twelve acres, the area

Fig. 3. Packing Bananas for Auckland.

capable of being worked by an Indian family, was successfully accomplished and by 1930, seventy-six percent of the cane crop was grown under this system, the proportion rising to ninety-seven percent in 1944; in the latter year the company grew only three percent of the crop, mainly for experimental and demonstration purposes. The system provides an example of cooperation between those who produce and those who process which is efficient to a high degree, comparable in the British Empire only with the Sudan Plantations Syndicate and its vast cotton plantations. The company provides transportation, processing, cultivation and manuring facilities, together—in many cases—with land, finance and technical supervision, while relations with the grower are governed by a contract under the provisions of which the grower receives his share of the proceeds according to the quality of cane produced and the market price of the final product.

Thus at the present time it can be said that the sugar and banana export industries and half the copra industry are based on systems of smallholder production, representing an overall proportion of three-quarters of the total agricultural exports of Fiji, though the efficiency of production, processing and marketing remains largely dependent

on the maintenance of technical supervision and financial provision formerly associated with the estate structure; efficiency, in fact, varies directly with the provision of these facilities.

During the depression period of the early 1930's there seemed a probability that the coconut estates, also, would gradually fall to be broken up into small holdings; a few have gone this way but the world shortage of fats and oils and the relatively stable price assured by a long-term agreement has reprieved the estates and enabled the majority of them to be rehabilitated and maintained.

Domestic Food Production

Apart from the export industries there is a considerable production of food for local consumption. The Fijian people have continued to be mainly self-supporting in their staple root vegetables but because of their bulky and perishable nature these do not enter largely into local trade. Until the importation of rice ceased during the late war the Indian community was dependent on imports for part of their requirements of rice and the whole of their sharps and flour; during the past few years the annual rice crop has increased from an estimated 10,000 tons to 17,000 tons, and the area planted with rice each year now exceeds 25,000 acres. Flour and sharps cannot be produced locally or adequately substituted, though maize is used to a limited extent. Indian smallholder livestock has developed to an extent which constitutes an industry in itself, supplying an estimated sixty percent of the local beef consumed in the colony together with a substantial proportion of the butterfat, though the factory butter industry is mainly dependent on European dairy farms.

The humid tropics are generally unsuited to the large-scale production of cereals; even rice can be grown only by family labour if a comparatively low wage equivalent is accepted, and its production for sale can be undertaken more efficiently under low rainfall irrigation conditions, as in Australia and California. The starchy roots, upon which the peoples of the humid tropics depend, have a relatively high labour requirement and are uneconomical in transport and incapable of being stored for long. It is, therefore, a matter for conjecture whether Fiji can expect to maintain even its present degree of partial self-sufficiency in staple food products. If the colony is to be geared to an economy of high production and high living standards, it seems that a greater dependence on imported cereals in exchange for sugar, fats and fruit will be a likely development.

Fig. 4. A Typical Sugar Cane Farming Settlement. The light fields are of mature cane, the other fields are of young plants or ratoon cane or fallow.

Fig. 5. Indian Farmers harvesting Cane with the Cutlass. The cane, stripped of its leaves, is carried to the mill by tramway.

Fig. 6. A Coconut Estate. A load of fresh coconut meat is being brought in by bullock cart to the dryer.

The future course of development will be determined by the interaction of a number of factors of which the conservation of the soil and forest cover against the pressure of a rapidly-expanding human population is perhaps the most fundamental; but one of the most important concerns the degree of economic and social adaptability which the Fijian is able to attain. The early loss of much fertile land by outright sale has been referred to, and this was followed in later years by the alienation of yet more land by lease, the pressure for which increased greatly with the cessation of indenture for Indian immigrants and the natural increase in population of this fertile and industrious people. But freed from the fear of gradual extinction by disease and a falling birth rate, stimulated by the contacts and experience afforded by whole-hearted participation in the war effort and by the recognition and support of his local administration, the Fijian is displaying a confidence and purpose that contrasts very strongly with his earlier acquiescence in passivity.

This resurgence is taking the form of increased participation in all branches of agriculture; not only is greater use being made of land remaining in Fijian hands, but there is strong pressure for the resumption of other farming land as leases fall due. Fijian farming communities are handicapped by lack of capital and business experience, but they are taking advantage of the newly-enacted Cooperative Societies Ordinance to adapt their traditional communalism to collective economic practice. Their productive effort is already no mean one: the estimated cash income of the Fijian community in 1947 was £1,210,000 of which £600,000 was derived from copra, £500,000 from wages, £50,000 from sugar and bananas and £50,000 from rents. As yet the Fijian plays only a small part in the sugar industry: the value of the cane grown by all farmers in 1947 was £1,250,000, but of the 90,000 acres under cane cultivation only 3,000 were farmed by Fijians, though the area is being increased year by year. The Fijian is naturally a gardener rather than a farmer; he has not shown much interest in cattle raising and management, and until he does so he cannot play his full part as a farmer. But with his present determination, and with proper guidance, the Fijian will undoubtedly be a major influence in the further development of his country.

SUBSISTENCE FARMING ON PONAPE

WILLIAM BASCOM

PONAPE, second largest of the Caroline Islands, is large only by comparison with the neighbouring islands of Micronesia. With roughly one-sixth of the total land area of the former Japanese mandate, Ponape has only 129 square miles and a population of 5,500. It is only one-fifth of the size of Stewart Island and has as many people as Westland. It lies almost midway between Truk, 383 miles to the west, and Kusaie, 307 miles to the east. Its verdant cover, mountain streams and waterfalls, and steep gorges are reminiscent of Melville's *Typee*. Rainfall averages 185 inches and more, and there are over 300 raindays each year. Ponape is a high volcanic island, rising to 2,595 feet in its rugged, cloud-shrouded interior. Farms and dwellings are scattered along the edge of the island, which is separated from the ocean by a belt of mangrove swamps, a narrow lagoon, and an encircling reef. The mountainous interior is uninhabited and is visited by Ponapeans only for wild foods which supplement an economy based on farming and fishing.

The succession of foreign powers which have ruled Ponape provides a useful chronology in terms of which changes in farming and other aspects of acculturation can be discussed with informants living today. Five stages are distinguished by Ponapeans: the native period (before 1826); the pre-Spanish period (1826-1886), dominated by American whalers and missionaries, which lasted until the establishment of Spanish rule; the Spanish period (1886-1899); the German period (1899-1914); and the Japanese period (1914-1945). The Ponapeans' 'historical' interest in plants is to be seen also in their mythology, which accounts for the introduction of almost all useful plants of the native period, except kava, to Ponape from Yap and other islands of the Pacific in legendary times.

Subsistence Economy

The present discussion is concerned primarily with the Ponapean subsistence economy (as distinguished from the commercial economy based on copra) and the prestige economy[1] associated with feasting,

[1] See William R. Bascom: 'Ponapean Prestige Economy', *Southwestern Journal of Anthropology*, Vol. 4, No. 2, 1948, pp. 211-221. Further details are available in *idem*: *Ponape: a Pacific Economy in Transition*, on microfilm at the Library of Congress. Fieldwork on Ponape from May to August, 1946, was carried on as a part of the U.S. Commercial Company's Economic Survey of the Trust Territory. The botanical identifications were made by Raymond Fosberg, and the entomological identifications by Richard G. Oakley, both members of the survey party.

in which large yams, pit breadfruit, kava and pigs figure prominently. Ponapean hunting and fishing and Japanese cultivation of copra, cassava, sugar, coffee, rice, pineapples, fresh vegetables and paper pulp, and the other economic activities of the Japanese and other foreigners are similarly excluded. It is further restricted to a consideration of the plant crops used for food purposes by Ponapeans, although cows, *carabao*, horses, goats, rabbits, cats, ducks, turkeys and geese have been introduced since contact and the traditional sources of food include pigs, chickens and dogs.[2]

Island Dietary

The basic item in the Ponape diet is a starchy fruit or vegetable, which constitutes the bulk of each meal. No meal, however, is considered complete without *sa:li*, a term used to indicate a protein dish of meat, fowl, fish, trepang or another kind of seafood. When none of these proteins are available, a sauce of chili pepper and salt may be used as *sa:li*. In recent times the European custom of offering guests a choice between baked, boiled or fried yams, baked breadfruit in two forms, boiled or fried breadfruit, fried bananas, boiled crab, fried fish, baked or fried pork, or soup has been adopted, particularly at feasts. When eating alone, however, all but a few of the most acculturated families follow the old pattern, where a single starch dish and a single protein dish are served. The starch and protein dishes are never mixed; they are cooked separately and served on separate leaves or plates.

On the basis of their function, Ponapean plant foods can be grouped into three major classes: (1) breadfruit, yams and their starchy substitutes which form one of the two mam dishes of each meal; (2) coconuts, turmeric, chili pepper, lemons and certain leaves and vines which are used as seasoning; and (3) wild and cultivated fruits, nuts, and

[2]Several plants, cultivated by Ponapeans for purposes other than food, need only be mentioned in parenthesis. Bamboo has been cultivated since it was introduced in the pre-Spanish period. Cotton and kapok, introduced during the German administration, are cultivated and used in making pillows. *Ilang-ilang*, introduced in the pre-Spanish period, is cultivated for its flowers which are used in making garlands and perfume. Derris root is cultivated and gathered wild for the manufacture of fish poison. Rubber trees were planted during the German administration, but rubber has never been produced commercially, and the trees today are useless and neglected. *Lantana camara* and a vine (*pa:tau*) with large yellow blossoms, introduced in the German period, were formerly cultivated as flowers, but both have gone wild and have become plant pests. Gourds were cultivated from the native period until bottles and other imported containers became available.

Tobacco has been cultivated since its introduction in the pre-Spanish period. Ponape is the most westerly point in the distribution of the Polynesian drink, kava (*Piper methysticum*), which has been cultivated since the native period. Coffee was introduced in the Spanish period and is grown in small quantities by a few families. Coffee, tea of leaves or bark, or imported tea is the first nourishment taken upon arising in the morning. Aside from this there are from two to five meals a day, depending on the eating habits of the family. The main meal is in the late afternoon.

green vegetables which are eaten between meals, but do not constitute a part of the meal itself.

Staple Foodstuffs

Breadfruit (*Artocarpus altilis*) and yams (*Dioscorea*) are the most important of the starch foods. With adequate fertile soil, coconuts, taro, arrowroot, pandanus and other staple crops of the coral atolls have been relegated to positions of secondary or minor importance. Breadfruit is important on neighbouring volcanic islands such as Truk and Kusaie, but it is doubted whether anywhere in Micronesia yams have assumed as prominent a position in the diet, or in the social life as on Ponape. The names of 78 native varieties of breadfruit and 156 varieties of yams were recorded. These are regarded by Ponapeans as different from one another, and are described as having distinctive characteristics which breed true.

All of the breadfruit varieties, but only eight of the yam varieties are said to have been in use on Ponape before contact with the outside world. Because of their interest in yams for prestige competition, Ponapeans were eager to experiment with the new yams from other parts of the Pacific and from South America which they obtained from the early whaling and trading vessels. Most of the varieties of yams in use today are said to have been introduced in the pre-Spanish period, but new varieties were added during the Spanish, German and Japanese administrations. Ponapeans today remember not only the period at which most of the yam varieties were introduced, but in many cases the part of the island where they were first grown and the name of the man who first grew them.

Seasonal Availability of Staples

In the mind of the Ponapeans, the year divides itself into two food seasons, that in which fresh breadfruit and that in which yams are eaten. This division is an idealisation which is at least in part fictional. Breadfruit is generally associated with the rainy and humid seasons, and is most plentiful about July and August, and yams are associated with the trade winds and are harvested in greatest numbers about December and January. In actual fact, however, yams and breadfruit can be eaten at the same time during a large part of the year.

The time at which breadfruit matures depends upon the variety concerned and varies from one year to the next and from one part of

the island to another. In one part of Mata:lanim district it is said that fresh breadfruit is available all year long. By planting both early and late varieties of breadfruit, and by picking late varieties from wild trees in the mountains after planted trees have been harvested, it is possible to eat fresh breadfruit at least occasionally throughout most of the year (May to February) in most parts of the island. The season at which yams mature also depends on the variety, the year, the part of the

Fig. 1. The Island of Ponape (surface configuration generalised).

island, and also on the time of planting. A careful farmer, by selecting the proper proportions of early and late varieties and choosing the correct time for planting, can have yams for feasts at any time of year, although it may be necessary to use some before they have grown to full size.

For most families, however, there are two between-season periods each year when neither yams nor fresh breadfruit are available in sufficient quantities to be served regularly. These lean periods occur about April-May, after most yams have resprouted and can no longer

be harvested, and before the full breadfruit season has begun; and about October-November, when breadfruit has become scarce, and before the season when yams have fully matured and are harvested. They do not constitute serious hunger periods since a number of other starchy foods are used as substitutes for yams and fresh breadfruit at these times. These substitutes are also occasionally used when yams and breadfruit are available, more often during the yam season, to stretch out the yams which have been planted, than in the breadfruit season, when most families have more breadfruit than they can consume. There is little desire for variety in food. Ponapeans are willing to eat breadfruit and yams, and particularly the latter, meal after meal and day after day.

The substitutes, in order of preference and their frequency of use, are *Alocasia*, 'western yams' (a type of *Dioscorea* regarded as distinct from the other varieties of yams which they cultivate), *Cyrtosperma*, taro (*Colocasia*), 'Hawaiian taro' (unidentified), cooked bananas and plantains, sweet potatoes, or cassava or tapioca, pumpkins or squash, and arrowroot. During the war large quantities of sweet potatoes and cassava were grown by the Japanese on Ponape, as a result of which their popularity has increased. Before the war they ranked between pumpkins and arrowroot, which is seldom used; these last four foods are all of minor importance compared with the first six. Pit breadfruit, breadfruit seeds, and imported rice are also used as substitutes for fresh breadfruit and yams.

Introduced Crops

Five of the six varieties of cassava were introduced in the Japanese period. Ponapeans say that the other variety which is poisonous was grown on Ponape before contact, as well as a variety of chili pepper and sugar cane, both of which are mentioned in Ponapean mythology, and of mango. All four of these plants were probably introduced through contact, but it is possible that they may have reached Ponape prior to 1826 indirectly from other islands which had had earlier contact with the outside world. Sweet potatoes were unknown until the Spanish period, pumpkins and squash until the German period, and 'Hawaiian taro' until the Japanese period. Two of the nine varieties of *Alocasia*, six of the twenty-seven varieties of *Cyrtosperma*, ten of the seventeen varieties of taro, and twenty-six of the forty-one varieties of bananas recorded were introduced since contact.

Fig. 2.
Planting Sprouted
Coconut.

Bananas have been markedly affected by contact. By the Spanish period, the most popular banana was one known as 'Brazil' (*Pre:sil*), introduced from that country in the pre-Spanish period by an American missionary. The three other important varieties in the Spanish period were, 'foreign bananas', also introduced in the pre-Spanish period, and *karat* and 'Yap banana', both of which are said to date from the native period, during which the latter was brought from Yap.

During the German period, these and many of the other bananas began to die off from an unknown cause. New varieties, better able to survive, were tried out and the 'Guam banana', introduced from Guam in the German period, became important. The banana root borer (*Cosmopolites sordidus* Germ.) was discovered two years after the beginning of the Japanese period, during which all of the older varieties of bananas suffered badly. A number of Ponapeans believe the root borer was introduced from Japanese ships calling at Ponape, but it may have been the undiscovered cause of trouble in the German period. Japanese authorities were unable to suggest a remedy for this pest, and Ponapeans tried burning the infested plants, burning over entire fields, and planting bananas in holes filled with ashes, with no success. The only satisfactory method found to keep the older varieties alive was replanting them frequently in new places, and Ponapeans are anxious to find a method of controlling the root borer.

Fig. 3.
Climbing Coconut Palm
to cut Drinking Nuts.

The search for new varieties of banana which could withstand its ravages continued in the Japanese period, and about ten new varieties were brought in from Palau, Angaur, Formosa, the Marianas, the Philippines, the Marshalls and other islands in the Pacific. Three of these have become the most important and widely used types of bananas today: *kalata:n* or *lakata:n* which is the most popular, 'Manila banana' from the Philippines which is now regarded as the same as the 'Guam banana', and 'Taiwan banana' from Formosa. The borer is found in all three of these varieties but is unable to kill them.

Ponapeans thus are dependent today upon three types of bananas, all of which have been recently introduced. In addition each farmer plants several other varieties, spending considerable time and energy on the older varieties just to keep them alive. Similarly, the two most popular varieties of taro were introduced during the German period from Kusaie and from Truk.

Domestic Use of Coconuts

Coconuts are of fundamental importance in the commercial economy. Copra was first sold to German trading vessels in the 1860's, and remained Ponape's principal export until the outbreak of the war, when it fell below both bonito and fibre exports, two industries which were developed by the Japanese in the 1930's. In the subsistence

economy, coconuts are used mainly as a cooking ingredient. Coconut oil is used in frying, cream squeezed from grated coconut meat is squeezed over starch or protein dishes, while grated coconut is mixed only with pit breadfruit and coconut meat and coconut husks are eaten only between meals. Coconuts are less important in the Ponapean diet than on the neighbouring islands, and are thought of more as a drink than a food. The juice of young coconuts and the boiled juice of ripe coconuts may be drunk either with or between meals.

Turmeric is also used as a cooking ingredient, but it is far less important today than chili pepper, lemon and salt, all of which are new since contact. The leaves and vines of taro and *Ipomea* are sometimes used in seasoning.

Subsidiary Foods

The foods eaten only after or between meals include corn, green onions, cucumbers, beans, eggplant, beans of the *Caesalpinia* tree, mango, oranges, tangerines, pomelo, pineapple, watermelon, pandanus, and sugar cane, which are cultivated, and limes, papaya (pawpaw), guava, soursop, cacao, mountain apple, Malay apple, Polynesian chestnuts (*Inocarpus*), Indian almonds (*Terminalia*), palm nuts, palm cabbage and several unidentified plants. The latter group includes both wild plants and others which, although no longer cultivated, were originally planted. These foods, most of which have been introduced, are not consumed as part of the meal, and are not regarded as 'real food' or nourishment. Some are planted just outside the house where they are readily available; some are grown on the farm and brought home and kept in the house ready for use when they are needed; and a number, which the Ponapeans speak of as being eaten only 'in play' are never brought home, but may be picked and eaten when one happens to pass the place where they are growing.[3]

[3]F. W. Christian (*The Caroline Islands*, London, 1899, p. 344.) states that the nuts of a tree which he identifies as a wild nutmeg were once chewed to make the teeth red, and a Ponapean manuscript mentions an unidentified tree (*ke:ma*) as a source of food in olden times; neither of these statements could be confirmed by informants today. The fruit of *Morinda citrifolia* and the yellow berries of *Ficus tinctoria* are seldom, if ever, used today. *Morinda citrifolia* and *Alocasia*, according to Ponapean legends, were the only foods available after the island had first been created and the first canoe-load of settlers had arrived. After the third canoe voyage, *Ficus tinctoria*, arrowroot, wild yams, taro and *Cyrtosperma* had been added to the food resources. Today *Ficus tinctoria* and *Morinda citrifolia*, like banana stalks, are not eaten except in cases of extreme hardship, such as the storm of 1905 which destroyed houses and breadfruit and coconut trees. Even the severest typhoons, however, have not caused real famine on Ponape, since yams, 'western yams', pit breadfruit, *Cyrtosperma* and *Alocasia* are not destroyed. These foods, which were available, even in 1905, constitute important reserves against periods of hardship.

Methods of Cultivation

Wooden or iron digging sticks and imported machettes are the principal farming tools, although special implements are prepared for picking breadfruit, picking flowers and husking coconuts. The method of planting varies considerably with the crop. A number of plants are grown from seeds planted in small holes two inches deep and two inches in diameter, made with a knife. In other cases, young plants which have sprouted from fallen seeds are simply dug up and replanted. Vines and vine cuttings, shoots and stem cuttings are also used, while breadfruit is grown from rhyzomes and pandanas from terminal buds. Some crops are grown from root cuttings planted in conical holes made by driving in a digging stick and wiggling it around to loosen the dirt. Yam cuttings are planted in mounds of loose earth formed over holes specially prepared with alternating layers of earth and green manure. The depth of this hole depends on the size of the yam desired. For yams for feasts, the hole may be five feet or more deep and it is believed that the yam will grow one foot longer than the hole is deep. Yams are planted above the holes because their main direction of growth is said to be downwards, while *Alocasia*, *Cyrtosperma*, taro and 'Hawaiian taro' cuttings are planted at the bottom of the hole because the roots are believed to grow upwards. The holes made for *Alocasia*, bananas and pandanus are sometimes as deep as eighteen inches, but most things are planted twelve inches or less below the surface, and it is believed that anything planted two feet deep will die.

Probably because of the heavy rainfall, newly-planted crops are never watered. Tobacco, corn, pumpkins and beans are shaded from the sun when they are first planted, and certain varieties of yams must be protected from the rain. Fertiliser is used only for yams. It is not used for breadfruit, coconuts or even taro, which is fertilised throughout the atolls of Micronesia. Irrigation, if the term can be used, consists of piling up a few stones in the beds of freshwater streams to make pools in which *Cyrtosperma* can be planted. Christian[4] describes the use of bamboo water conduits to 'bring down water from the hills for irrigation purposes', but informants today say that this practice was confined to the small island in the lagoon on which Christian resided. Artificial pollination is used for one variety of pumpkin or squash.

Bananas, pineapples, taro, 'Hawaiian taro' and sugar cane are

[4]*Op. cit.*, p. 343.

Fig. 4.
Yams protected by stone walls from pigs, and trained to breadfruit trees.

replanted to make them grow better. When these were grown in the mountain farms, they were transplanted annually to the new fields. Yams, which are sometimes left on the farmstead to grow for a number of years, are replanted after five years for the same purpose. Two methods were used to make breadfruit, coconut, mango and citrus trees bear more fruit. The trunk of the tree was ringed about two feet above the ground with a series of short cuts in the bark, taking care not to make a continuous cut clear around the tree; or a few dry coconut fronds were laid about the base of the tree and burned, taking care not to burn the bark too severely. Both of these traditional methods have been replaced by a third method introduced during the German period: an iron rod about three-eighths of an inch thick and nine inches long is driven into the trunk of the tree. Any of these three operations has to be performed only once to improve the fertility of the tree as long as it lives. When a young breadfruit tree has reached the height of six feet, a vertical cut is made in its bark to make it grow faster, and a few months later when new leaves are appearing, the top is trimmed off so that it will have many branches and not grow too tall.

Immigrant Pests and Weeds

Farming has also been affected since contact by the appearance of new pests, such as the banana root borer, the taro leaf hopper which

Fig. 5.
Cyrtosperma growing in Stream Bed.

appeared about 1921 with a new taro variety from Saipan, the coconut hispine beetle and coconut scale which appeared together about 1936 from Saipan, and a cutworm which attacks tobacco, corn and beans. *Ipomoea gracilis*, *Dioscorea bulbifera* and a third vine (*i:ol*) which Christian identifies as a giant convolvulus, all dating from the native period, climb to the tree tops and kill breadfruit and coconut if they are not cut and pulled down regularly. *Wedelia biflora*, which dates from the native period, *Lantana camara* and *pa:tau*, which were introduced as flowers in the German period, a plant called 'Paddle grass' and *Pennisetum*, which were introduced by the Japanese for cattle feed and paper pulp are also very troublesome. These plant and insect pests have prevented the production of certain plant varieties and have made farming difficult in certain areas. The most dangerous pest, and one which threatens all farming on Ponape, is the giant African snail (*Achatina fucila* Fer.). This was first introduced to Ponape from the Marianas about 1937 by Okinawans, who grew them for food purposes. Large areas are heavily infested and, lacking controls suitable to Ponape, there is a danger that the whole island will be overrun.

Patterns of Land Use and Tenure

Before the Japanese placed restrictions on the use of land, farming was done on the farmsteads near the house, on the nearby mountain

slopes, and in freshwater marshes. On the farmstead women grew onions and sugar cane and men planted breadfruit, coconuts, yams and occasional mangoes. Parts of the farmstead were allowed to lie fallow, and the soil was also revitalised by cutting and burning every five years or so, when crops failed to do well. Until the German period, when the farmsteads became private property, land tenure was based on the private ownership of crops. A man enjoyed exclusive rights to his farmstead as long as the breadfruit and coconut trees he had planted continued to bear, and tenure could be inherited by his heirs and extended by planting new trees. The ultimate title to all land was vested in the district chiefs, who received tribute in the form of first fruits, feasts and free labour from the commoners in return for its use. The German administration restricted the economic privileges of the chiefs and gave commoners outright title to their farmsteads.

In the mountain farms yams and *Alocasia* were planted by men; taro, 'Hawaiian taro', corn and sugar cane were grown by women; and bananas were planted by either men or women. Except for yams, the crops grown in the mountain farms were those believed to require sun. Most of the women's farming was done on the mountain farms, whereas the important men's crops were grown largely on the farmstead. The mountain farms were prepared by men during the season of the trade winds, between December and February. First the weeds and brush were cut down with a knife, which took about a week for the size of mountain farm usually made. The weeds were allowed to dry for another week and then burned. If the plot contained trees too large to be cut down with a knife, they were killed by burning dried brush piled around their base. Planting could begin the day after the burning, and required about two days for men's crops if the seeds had already been collected; if seeds and cuttings had to be gathered in the mountains, at least another day was necessary. Men and women planted in the mountains at the same time, each digging their holes for their own crops. The entire crop was harvested or transplanted at the end of the year, when the field was abandoned and a new one was prepared. After one crop the land is considered exhausted and to require a fallow period of at least two to four years, by which time it had been overgrown with grass. Unless the field had large trees growing on it, indicating that the soil was good, the fallow period was much longer and the field had to be cleared of a heavy second growth before it could be used again.

In the freshwater marshes, where the cover of water varies seasonally

from a few inches to a few feet, *Cyrtosperma* is planted by men in holes made in the mud with a digging stick. Since the marshes do not lose their fertility, the same plot is replanted year after year. *Cyrtosperma* is often allowed to grow for several years before being harvested, reaching a large size, and tenure again is based on the ownership of the crop.

Effects of Japanese Occupation

During the Japanese period all unoccupied lands, which had originally belonged to the chiefs and had been made district property under German law, were declared property of the Japanese administration. The Japanese called in the land deeds issued by the Germans and struck out the article which provided that all land for which no titles had been issued belonged to the district, and that any Ponapean who wished to take part of it as his own could do so with the consent of the district chief and the governor. Through this, and through requisition of native lands for airfields and naval installations, a landless class developed which numbered about 150 families in 1946. Licences were required to fell trees, hunt and farm in these lands, with the result that almost all Ponapean families abandoned their mountain farms, losing an important source of food. The largest of the freshwater marshes were also in the former district lands, and the best of these were taken by the Japanese for rice paddies. A few fortunate families had small stream beds within their farmsteads where they could continue to grow *Cyrtosperma*, but most families gave up the cultivation of this food which could be substituted for yams and breadfruit in the lean periods between the two major harvests. With farming restricted to the farmstead, fallowing was abandoned. All the crops had to be produced on the farmstead and it was necessary to use land continuously regardless of the danger of soil exhaustion, which the Ponapeans recognised. This situation continued through the war and during at least the first year of American occupation while the former district lands remained legally in the category of Japanese property.

Agriculture was disrupted during the war through the Japanese programme of forced labour. Ponapeans were required to work on military installations and on farms established to feed the increased Japanese population when Ponape was cut off from Japan in 1943. The traditional division of labour by sex was disregarded, and men and women worked side by side in the fields, growing sweet potatoes, cassava, paper pulp and wet rice; and Ponapeans regarded work in

Fig. 6.
Road through
Native 'Farms'.

the rice paddies as most unpleasant. With nearly all able-bodied men and women taken from their farms, both subsistence and export crops suffered. Copra production fell off until exports were completely stopped by the submarine blockade, and coconut trees on the Ponapean farmsteads and Japanese plantations were overgrown with vines. Unable to plant yams or harvest breadfruit Ponapeans ate in field kitchens or Japanese restaurants.

United States Trusteeship

Liberation, following the Japanese surrender to American troops, meant to the Ponapeans, above anything else, the right to return to their farms. Copra production was slow in reviving, but subsistence farming began immediately. Although little flour, rice, milk, canned fish and meat, tea or other imported foodstuffs were available, neither the war nor the period of reconversion saw real hunger on Ponape. On the other hand real hardships were felt while imports of cloth and hardware were cut off.

A century and a quarter of contact with the outside world has seen the modification of Ponapean agriculture through the introduction of new crops and new varieties of known plants, through the appearance of new pests, through changes in land tenure imposed by foreign rulers, and through the development of the commercial production of copra for export. Ponapeans today are linked with the outside world

Fig. 7.
Ponapean House with Taro and Bananas.

and depend upon a market for their copra at prices adequate to pay for the imported goods upon which they have come to rely as a result of the acquisition of new tastes, the development of new needs, and the disappearance of traditional handicrafts through the competition of manufactured goods. This fact poses the major problem for the new American administration if the Ponapeans are to have a standard of living equal to that they previously enjoyed under the Japanese.

With the exception of the control of snails and other pests, the problems presented in the field of subsistence agriculture are less difficult. Despite the Japanese land regulations, most of the Ponapeans had not been dispossessed of their land, and subsistence farming continued to have an important place in the economy. As a result Ponapeans have not starved either when the world market price of copra has dropped during depressions or when the island has been cut off from the outside world during the war. Flour, rice, milk, canned meat, canned fish and other imported foods are needed in relatively small quantities, and there is room for improving the quality of the diet in other ways, but Ponapeans have been and are still able to produce food in adequate quantities for their own needs. With the Japanese population evacuated, there is more than enough land to take care of the present population of Ponape, and correcting the inequities of Japanese land laws would not seem to present any serious difficulties.

PLUNGING CLIFFS, LYTTELTON HARBOUR*

C. A. COTTON

LYTTELTON HARBOUR (*Fig.* 1) is connected with the sea by a narrow strait which opens to the east-northeast—a direction from which a really heavy swell very rarely comes. Three miles within the heads such a harbour should be as good as landlocked; or so one might expect when its outline and form, as they appear above water, are compared with those of other harbours. Moles, it would seem, ought not to be necessary to protect shipping at the wharves. Yet at Lyttelton no one need doubt that the moles have their use; they are, indeed, indispensable. Sheltered by these protecting walls as the inner harbour is, it is even so subject to a very troublesome 'range'—a to-and-fro surge of water which makes necessary the use of heavy 'springs' of hemp rope for mooring ships. The range results, very obviously, from an ocean swell which sweeps up the harbour entrance, passes on far beyond the moles, and exhausts itself only by breaking on the mudflats of Governors Bay.

The crossing by ferry from Lyttelton to Diamond Harbour is rarely smooth, and as the southern side of the harbour is approached, the ever-present swell asserts itself as a persistent and savage forward lunge and withdrawal of water along the rocky shore. This manifestation is to be observed all around Lyttelton Harbour and in the bays of Banks Peninsula; and without the protection the moles afford at Lyttelton these would be the conditions at the wharves and on the foreshore of the port. At the foot of the cliffs at Sumner Head also, on the Christchurch side of Lyttelton Heads, and indeed in all similar places around Banks Peninsula, the swell is seen to sweep along the shore instead of curving in and breaking on the rocks.

Probably most dwellers in Lyttelton and Christchurch accept such conditions as normal, but they are really abnormal when compared with what is found within the inlets of most other embayed or 'drowned' coasts. Normally such embayments, whatever their cross-section was initially, are now shallowed as a result of the accumulation of sediment. Such infilling has, indeed, taken place in Lyttelton Harbour and all around the peninsula, but there is a difference in the kind of material forming the sediment and in the manner of its accumulation.

*Address delivered at a meeting of the Canterbury Branch of the New Zealand Geographical Society, August 10, 1949.

Though muddy in parts, and agreeing to this extent in texture with Lyttelton mud, the silts of most bay-fillings grade into coarse sand and perhaps gravel or boulder beaches at the sides; and such materials have come to rest somewhat compactly, and in a sense permanently, so that the bottom has assumed a form with floors shelving or sloping out gradually from the shores towards the deeper axis of a bay or channel. This being the common form of the shallow-sea floor, it is not surprising that refraction of ocean waves takes place as they approach the land and enter the mouths of most bays. It is well known that the energy and work of waves are thus concentrated on headlands

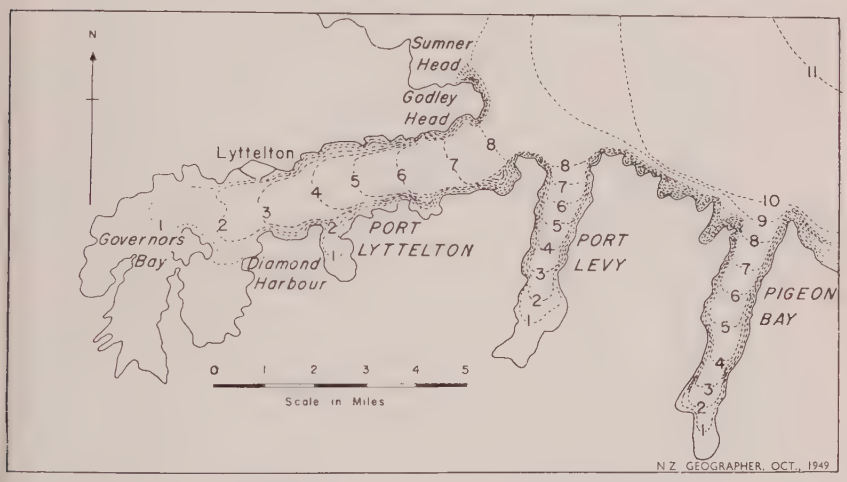

Fig. 1. The floor of Lyttelton Harbour and the northern bays of Banks Peninsula. Contour interval: 1 fathom.

and there expended in a zone of breakers. The channel leading into a bay, on the other hand, spreads out the orthogonals, or lines of propagation, of the waves just as rays of light are caused to diverge when passing through a concave lens—and for the same reason. In the lens rays bend in the direction of the thicker part of the glass, being retarded as they pass through it; and in the bay the waves turn towards the shallow water, for the shallower the water the more is the wave velocity retarded. A swell running for any considerable distance through a channel with shallow water at the sides, is damped out, for the waves swing around towards each side of the channel and run in towards the shores, breaking there on beaches so as to dissipate their energy.

A brief comparison of Lyttelton Harbour with Port Nicholson is worth while. The entrance to the latter lies open to the south, and is swept by heavy seas during southerly gales, but no swell coming from the open ocean breaks on Petone beach, though this beach faces south at the head of a straight channel leading through the harbour entrance to the open sea; and the channel is neither landlocked nor beset with protecting sandbars or mudflats. At Lyttelton the case is different, and the difference depends on the cross-section of the channel, the explanation of which is bound up with the history of its origin.

Volcanic Origins

The harbour is a drowned valley, which was developed by erosion before it was submerged, running water hollowing out the centre of an ancient volcano. Though this is not the whole story, and this fact will not of itself account for the peculiar behaviour of the swell in Lyttelton Harbour, the explanation has to be substantiated as a preliminary to the further examination of the problem. Banks Peninsula was formerly an island, as may be gathered from evidence of the marine cliffs which indicate a former shoreline along the foot of the hills between Christchurch and Motukarara. The island began its existence as twin volcanoes. These were rather low, smoothly convex domes like those of the Hawaiian Islands and Western Samoa, and were built almost exclusively, in their later stages of growth, of extensive sheets of far-flowing lava. One dome had its centre over the great bowl-shaped hollow which is now the upper harbour at Lyttelton (*Fig.* 2), and another was similarly placed over Akaroa Harbour. The Akaroa dome is the larger, and overlaps somewhat that of Lyttelton, since it continued to grow, apparently, until a later date. As a result, most of the bays of Banks Peninsula indent the margin of the Akaroa dome.

These bays are erosion-cut valleys partly invaded by the sea, and between them there are still extensive radial strips of the original gently sloping surface of the dome (*Fig.* 3). Professor Speight has described also mushroom-shaped bodies of light-coloured lava (trachyte) standing above the dome surface, which have been squeezed up through cracks in the Akaroa dome and have accumulated over the orifices because the material has not been liquid enough to spread out and flow away.[1] Some other volcanic-island domes are adorned with knobs of similar origin.

[1]R. Speight: 'The Geology of Banks Peninsula—a Revision', *Trans. & Proc. Royal Soc. N.Z.* Vol. 74, 1944, pp. 232–254.

Surface Erosion

When growth of the volcanic domes ceased, streams of water which were by that time running radially down the slopes proceeded to cut the many valleys now forming bays around the peninsula. One such stream, however, on each volcano gained a mastery by extending headwards so as to breach the crown of the dome and thus gather to itself so much drainage there that it grew to be a river of considerable size. As a result of this activity the central part of each dome was hollowed out, and great cliff-like escarpments were formed along the outcrops of outward-sloping lava sheets. Such cliffs, facing inwards towards the centrally excavated hollow, became higher as the hollow was deepened by the eroding river and its circle of converging headwater tributaries. As these nibbled back headwards they caused the ringlike escarpment to retreat, until it has become today the precipitous wall around a great eroded bowl in the central part of each of the domes (*Fig.* 2). Most of this erosion took place before the sea entered the valleys of the master rivers to make the present harbours; but it is still going on. The vast hollows have been called 'calderas', and in the early days of Canterbury geology it was believed that they had been opened by explosions capable of blowing the heads off and of eviscerating the high-peaked volcanoes then regarded as typical.[2] Debris scattered by such explosions is not to be found, however; and, moreover, none of the details of form in the landscape of the present day are consistent with such a theory of origin of the great hollows. Many years ago (though he did not express his opinion in print until 1917) Professor Speight found these details of form to be such as to support an explanation of origin by river erosion.[3] In this opinion Professor W. M. Davis, the greatest authority on landforms, fully concurred when he visited New Zealand in 1914[4]; and no later investigator has questioned the explanation adopted by Speight.

Erosion Caldera and Barranco

The term 'caldera' is taken from the name of a great hollow of similar form on the volcano of La Palma in the Canary Islands, but this too has been shown to be a valley excavated by a river and its headwater tributaries. Though the word 'caldera' is now used in the

[2]J. von Haast: *Geology of Canterbury and Westland*, Christchurch, 1879.
[3]R. Speight: 'The Geology of Banks Peninsula', *Trans. & Proc. N.Z. Institute*, Vol. 49, 1917, pp. 365-392.
[4]W. M. Davis: 'Banks Peninsula, New Zealand' in *The Coral Reef Problem*, New York, 1928, pp. 151-154.

description of unusually large craters of true volcanic origin, great eroded hollows such as are found here are known as 'erosion calderas'. The gorge-like exit of the river from its catchment basin, breaking through a broad lava ring, is the 'barranco' (taken from the name of this feature at La Palma) and the narrow entrance to Lyttelton Harbour was so described by Sir Julius von Haast.

The entry of the sea by way of the barrancos into the erosion calderas, as well as the drowning of the many radial valleys on the Banks Peninsula domes, has also to be explained. Before this took place the peninsula had very nearly reached the perfection of detailed erosional form which it has today. The walls of the barranco at Lyttelton had become nearly vertical cliffs and around the periphery of the domes the attack of ocean waves working for long ages had developed high vertical cliffs, which now descend below sea level as 'plunging' cliffs.[5]

When these were undercut and steepened by marine erosion the sea stood at a much lower level than it does now. No doubt this was during the Ice Age, when for long periods the ocean had been robbed of much water which was used up in the making of vast continental ice sheets. A fair estimate of this temporary lowering is 300 feet. With the melting of the ice and the return of much meltwater to the ocean came the invasion of the valleys of Banks Peninsula by the sea, and at the same time the bases of the external cliffs became deeply submerged. This is true whether or not the volcanic mass has sunk at some time or other under its own weight.[6] It very probably has done so, but there cannot be much doubt that the present stand of the sea around this

[5] W. M. Davis: *loc. cit.*
[6] See R. Speight: 'Geological Features of the Christchurch Artesian Area', *Trans. & Proc. N.Z. Institute*, Vol. 43, 1911, pp. 420-436.

Fig. 2. Lyttelton Harbour. *Photo: V. C. Browne*

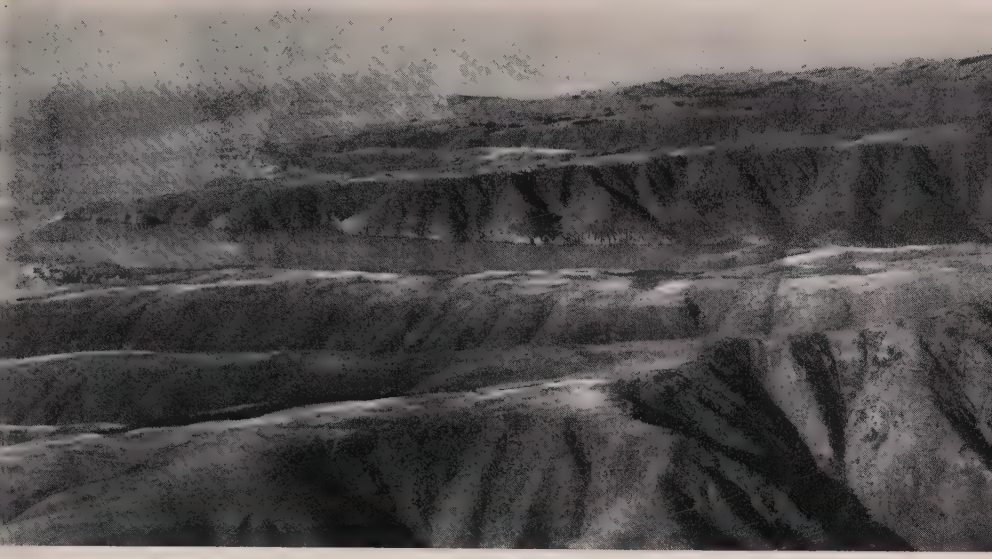

Fig. 3. View eastward across Pigeon Bay and the northern slope of the Akaroa dome, Banks Peninsula.
Photo: V. C. Browne

coast has been taken as a result of the more general cause. All over the world there is evidence that the level of the ocean has risen since the Ice Age.

Plunging cliffs that have suffered this partial submergence only a few thousand years ago are not confined to Banks Peninsula, but here circumstances have combined to delay the attack of waves at the new sea level. Waves do not break with much force against vertical walls such as these plunging lava cliffs present, but are reflected from them; and there is no resting place in the zone of attack for coarse debris such as waves can use, if it is available, as abrading material with which to cut away the land.

The Role of Redistributed Loess

Since the drowning of the cliffs and valleys took place, however, the water has not remained deep around these cliffs and in the newly-made bays. Sediment has accumulated, but this is sediment of an unusual kind, not the usual debris of local origin, newly-eroded gravel and sand. Such material, though some of it must be present, does not predominate here. Its place is largely taken by a very voluminous deposit of impalpable silt washed down by rain from the lower slopes of the peninsula and the sides of its valleys, where it had accumulated in the recently-ended glacial episode. Some of this may still be seen on the slopes, but the deposit is furrowed by close-set gullies. Vastly more of it has been washed down into the sea. This material is loess, carried by northwest winds from dried-up outwash deposits derived from glaciers in the Southern Alps, and caught and held by the steppe

vegetation which clothed these hills during the Ice Age. Washed down in later times and redeposited in the sea, this peculiar silt refuses to settle down in normal fashion. Its surface layer is stirred up by the waves of every storm. The water here remains, indeed, always turbid, as is indicated by the prevailing Nile-green tint of the sea. When some of the silt sinks to the bottom, perhaps only temporarily, it settles into the deepest water available and comes to rest there with a level surface. Thus it is never banked against the plunging cliffs, and charts show alongside these water as deep as is to be found some miles offshore. (*Fig.* 1).

The silt forms only the flat floor of the channel into Lyttelton Harbour, the sides of its box-form underwater cross-section being the plunging cliffs of lava rock in the walls of the barranco. The underwater profile across the harbour is flat-floored from side to side, as a glance at a chart will show. At Godley Head the harbour depth is eight fathoms all the way across from cliff to cliff; a mile inside the heads the depth from side to side is seven fathoms; and yet another mile farther in the floor is still flat from side to side with a depth of six fathoms.[7] When a swell from east-northeast enters the barranco, therefore, absence of shelving sides prevents the refraction of waves and the dissipation of their energy on side beaches which are usual in similar channels; and this is the explanation of the persistent swell which makes its way into the upper harbour and even troubles the water within the sheltering moles. The persistence of the swell, moreover, explains the troublesome mobility of the harbour silt.

Is there a remedy? Is it possible to have here a harbour as good as the landlocked basins of Wellington and Akaroa, or one in which a dredged channel may be relied on to remain open? Whether there is a remedy or not is a question for engineers; but it would seem to be a large order to alter the cross-section of the barranco, or even of a part of it. If vast quantities of rock from the basalt escarpments were broken down by a feat of engineering in an attempt to build an underwater glacis on each side of the channel, it is not easy to picture what the effect of such a load would be on the unstable mass of fine silt that lies in the barranco and forms the floor of the harbour.

[7]See also C. A. Cotton: *Volcanoes as Landscape Forms*, Christchurch, 1944, Fig. 222, p. 396.

MAINLY ABOUT THE SOUTH ISLAND: IMPRESSIONS OF AN ENGLISH GEOGRAPHER

F. H. W. GREEN

I LONG HAD a desire to visit southernmost New Zealand, and although my yearning crystallized particularly on the South Island, I was destined first to set foot in New Zealand at Whenuapai. A brief fifteen hours—a taxi-tour round Auckland under the full moon, including a panorama of the harbour from the cone of Mount Eden, and an air view the next morning of the coastal farmlands along the shores of the Hauraki Gulf—merely served to whet my appetite for more.

The opportunity came when, at the end of October 1945, H.M.S. *Newfoundland* received orders to visit the South Island. I obtained permission to sail with her and take leave ashore until she left New Zealand waters. As a result of this I had eleven days, in which I resolved to risk the possibilities of physical and mental indigestion and to rush round the island by bus and train.

Fiordland

The first landfall made by the *Newfoundland* was the long line of the Southern Alps of Westland and Fiordland. The aptness of the Maori name for New Zealand was at once impressed on us, but we argued whether Aotearoa referred metaphorically to the white line of snow-tipped peaks, or more literally to the streaks of lenticular cloud which on that day, as doubtless on many similar days, happened to float over the mountains. At any rate, we were very lucky. We had the day before passed a cold front, with incidentally a well-marked temperature fall of 8°F, and were free of the overcast skies which had marred our first forty-eight hours out of Sydney. The swell was slight, the afternoon was sunny, it was spring, and we were eagerly scanning the mountainous wall for the small whitewashed beacon which marks the entrance to Milford Sound.

We had obtained permission to make history by being the first warship to enter the sound since H.M.S. *Dunedin* had paid a visit some years before the war. Turning the cruiser 'Port ninety' to enter the sound was rather like entering church by the side door and one felt somehow that the *Newfoundland* should have a hat to doff as she

proceeded up the aisle, which is the fiord. It was not long at least before we lost the appearance of a fighting ship ready for action, and all hands appeared on deck—the stokers relieved each other on watch—and climbed to points of vantage to take photographs.

All were impressed by the minuteness of the ship as she steamed slowly up to our turning point at Harrison Cove, and all felt the loneliness and remoteness of the sound. One had not to look far for textbook examples of morphologic features. The compass platform of the *Newfoundland* was an excellent vantage point for viewing truncated spurs, a fiord-head delta, and hanging valleys, notably the one above the photogenic Stirling Falls. But there was nothing physiographically new, and for novelty we turned to the vegetation. The fiords of Norway and Scotland have not the profusion of vegetation down to the water's edge; trees and ferns are to be seen not only inside the fiord but on the open coast.

Southland

We used up our films and the time came to leave the sound and travel southwards along the coast of Fiordland. How delightful it would have been to explore some of the other inlets. But there was a timetable to keep to, and we were expected at the Bluff next morning. So we rounded Puysegur Point and found our way through the islands of Foveaux Strait, which, on paper, are familiar to all midshipmen through the Admiralty's choice of that locality for a navigational exercise chart. Foveaux Strait makes one feel at home, and soon the mass of bracken and flowering gorse of the Bluff beckoned us as though to a Cornish harbour. Keep one's eyes off the backdrop of snow-tipped mountains, and the little township of Bluff appears like a small Australian country town set down on the coast of Cornwall.

Invitations appeared for us in no time from the citizens of Invercargill. It was a typical kindly practical New Zealand thought on the part of a magistrate to ask us to join him and his wife and to take a billy with us to have tea somewhere by the wayside. Thus I got my first impressions of Southland as we went westwards across the plain to Otautau on the Aparima River and so into the hillier country towards Tuatapere in the valley of the Waiau. I wrote at the time that the countryside appeared like a sunnier Morayshire, and one might say a yellower Morayshire, for the gorse was in full blossom, and was more in evidence than I had expected, equipped though I was with knowledge

of the alarming spread of this immigrant. Broom was a familiar sight, but a striking new note in the landscape was provided by *Phormium tenax*, the New Zealand flax.

Just as the thorn and the blackberry hedges of England play a part in the visual landscape which is out of proportion to the area actually occupied, so do the roadside verges of gorse and flax, and the cropped gorse hedges, play their part in the landscape of the South Island plains. Gorse however is a pest, and everywhere is evidence of the fight against its yellow-blossomed challenge. The roadside verges have had to be ploughed up by the road authorities in order to check the spread of this flowering thorn, and characteristically we made the fire for our billy from dead gorse taken from the roadside. In death it behaves as in life, for as a fuel it is far more spectacular than efficient, and one was afraid of causing a large conflagration.

The economic difference from the Morayshire scene lies in the preponderance of sheep. As for the homesteads, they are of course generally similar to their Australian counterparts but advantage has frequently been taken of the relatively favourable soil, climatic and 'microtopographic' features, to grow flowers. I think it is not entirely a reflection on the generally dry and sandy Australian countryside to say that the New Zealand homestead immediately strikes one as being more garden-conscious.

This brings me to another point. In Australia one is scarcely ever distant from the natural eucalypt woodland. Clear a tract of gum trees and their progeny will soon have taken their place. The Australian country home is blatantly in an Australian setting—of gum trees. But in the cultural landscape of New Zealand one searches almost in vain for traces of the natural vegetation. Apart from the literally pointed efforts of *Phormium tenax*, it is a reticent flora. The native New Zealand trees take too long to grow to be able to compete with the more rapid-growing and indeed more useful imported species. It was only after travelling many miles, and deliberately seeking it, that I was able to stand surrounded by such native New Zealand bush as we had seen on the inaccessible shores of Milford Sound.

Back at the Bluff, I spent one more night in the ship, and then started off first thing in the morning undecided what to do until I reached Invercargill. An irritating feature of wartime life almost everywhere is the inability to obtain pocket timetables. New Zealand was no exception, and so a journey could not be planned much in

advance. But I found the N.Z.R. Road Service Office extremely helpful, and they promised me the front seat in a bus leaving for Queenstown in a couple of hours' time.

In the meantime, a few rapid impressions could be absorbed of Invercargill—the wide streets, which I discovered only later to be the subject of a South Island perennial joke about having lunch halfway across; a better bookshop than I could remember seeing in wartime Australia, with an obliging salesman with a Scots accent, who arranged for me to get the maps I wanted from the Lands and Survey Department. The latter is worthy of comment in itself, housed in a rather old building and extraordinarily reminiscent of a provincial office of an English government department. Yet comparison with England emphasises the youth of the country, for the Ordnance Survey of the United Kingdom no longer finds it necessary to have provincial offices of its own, since its map sales can be handled easily through agents. The tasks of original survey are not complete in New Zealand and within eighty miles of Invercargill one can find tracts of Fiordland which have to be marked on the map not merely as 'unsurveyed' but 'unexplored'.

Central Otago

I took my seat in the bus and we started off towards Winton and Lumsden, across a countryside similar to that of the day before but which after Lumsden gradually began to give place to something reminiscent of the sheep hills of Galloway. At last some native vegetation began to appear once more, but this time it was tussock grass on the unimproved slopes. And so on to Kingston, on the south arm of Lake Wakatipu. Here the tussock was thin, and I began to be impressed by the somewhat unexpected barrenness of the scene. The subconscious thought that there was in Norway or in Great Britain an analogy for most things in New Zealand suffered the first jolts of a shock the full impact of which was to be felt on the morrow.

Only near Queenstown did I see more than a few isolated trees on the shores of Wakatipu, and they proved to be a plantation of exotics. I did not of course have a chance of visiting the upper end of the north arm of the lake, where there are patches of thick native west coast beech forests. Sunset on the shores of Lake Wakatipu by Queenstown is a memorable sight, with tippets of white snow on the summits of the Remarkables. I wondered about the individual whose note-

worthy understatement was responsible for this official description of a really impressive range.

A bed for the night in a small wooden hotel was a reminder that Queenstown, like its neighbour Arrowtown, started as a mining settlement before becoming a tourist resort. I found time before retiring to visit the office of the bus company which ran the service to Cromwell—the impressive name 'Mount Cook and Great Southern Lakes Tourist Company'—served to underline in my memory the fact that not all the passenger road services of New Zealand have been nationalised.

We made a literally halting start the next morning, for the bus driver had a more than usually formidable array of newspapers and parcels to deliver on route to Arrowtown; and he seemed more careful than the average to stop opposite the loaf-shaped metal letter boxes which are such a feature of the New Zealand rural roadsides. The usual practice with newspapers is to throw them on the verge while the bus passes at full speed. Arrowtown looks much more the old mining settlement than Queenstown, for it has not had a large tourist industry superimposed on it; it is an attractive little spot with a tree-lined main street sheltering under spurs of the Harris Mountains.

After Arrowtown, the countryside gradually becomes drier, and one passes through a series of rather sombre gorges. One realises one is in a geomorphologist's paradise. It is not that there are features that one has not seen before. But here they all are; in one sweep of the eye one can see textbook examples of an enormous number of glacial and fluvioglacial features, both erosional and depositional, to see individual examples of which in any other country one would have to travel miles. Terraces were perhaps the most outstanding phenomena, with several impressive examples of flat rock terraces on which had been spread, like a very liberal ration of butter on a loaf, flat depositional terraces of gravel.

Soil erosion has of course been at work everywhere as the tussock grass has disappeared, and the butter on the loaf shows what look like the tooth marks of some gigantic naughty child who would not eat the bread. Suddenly one realises that some naughty children had indeed been in here in the form of gold sluices and that much of the erosion on the terraced shoulders of the gorges had been initiated by them, and that the responsibility must not all be laid on immigrant animals. Remains of sometimes almost Heath Robinsonian aqueducts were at

hand to remind one that the alluvial gold miners had tackled almost every stretch of gravel on to which sluice water could be turned.

Near Cromwell and Alexandra were some irrigated pastures and orchards on the valley flats, which but served to emphasise the dryness of the surrounding hills. From Alexandra to Roxburgh high above the gorge of the Clutha River, the road winds across spurs of hills which are as near to temperate desert as anything I have ever seen. One knew that Central Otago was dry, but here, where the native tussock has all but disappeared, is a man-made desert which though topographically different, could bear comparison with those deserts which were once the wheatlands of Roman Africa. I cannot overemphasise the impression made on me, a ten-day tourist, by this desert of Central Otago. Approaching Roxburgh, the road comes down closer to the river and the tailings of the alluvial gold workings come more prominently into view. They are a hideous sight, like abnormal moraines, but some success seems to have been achieved hereabouts in planting them with conifers.

So to Dunedin

Roxburgh is a charming little example of the fruit-growing centres of the Clutha and its tributaries. As we left the main valley to pass via Lawrence to Milton on the coast road we found that the unstable air mass whose showers we had last experienced at Lumsden was still yielding its convectional precipitation, and so we finally approached Dunedin in the rain. My first impression of Dunedin remained for the three days I was there—a Scottish town in a Devonshire setting—with plenty of evidence in the dusk, notably in the lavish use of neon signs, of the South Island's copious cheap hydroelectric power.

I fell for Dunedin, as indeed did the whole ship's company of H.M.S. *Newfoundland*. Dunedin seems to have most of the ingredients for a full life, some of which it has to be admitted are so commonly lacking from the new towns of the southern hemisphere. The Scottish educational and cultural tradition is so much in evidence that it is hard to believe that this town is not as near as Ireland but is in fact 13,000 miles from old Caledonia. There is even living history in the shape of mid-Victorian cable trams such as disappeared from Edinburgh soon after the turn of this century. Here we were in a Britain growing on the same nineteenth century trunk as the homeland, but we were now out on a different branch on which some of last season's fruit had

remained, but which now had some freshly pollinated blossom of its own.

A visit to the R.T.O. ensured me a seat in the train to Christchurch, and I started off on a very pleasant ride through terrain which is extraordinarily reminiscent of the old country. Copious rainfall has permitted the development of a cultural landscape which has the finished appearance of Europe, and the green fields might easily be in the English West Country. A stop at Oamaru emphasises this impression, for instead of the usual wood or brick construction Oamaru's main street is built of local easily-worked limestone which is not dissimilar to some of the Jurassic building stones of England.

And so on to Timaru, along a coastline whose deficiency in harbours reflects its recent geological history. One now reaches the Canterbury Plains and the reminders of England's West Country vanish. Again as in Southland one could imagine oneself in the Moray Firth Lowlands of Scotland, with such rivers as the Rangitata and Rakaia replacing the Spey and the Findhorn. We passed the Christchurch suburbs, with race crowds on the platform at Addington, and came into that homely station which serves as a rather congested entry to the South Island's largest town.

Christchurch has been so well and so often described as being practically an English town that one is almost relieved to find that its rectangular streets provide a marked difference from anything in the old country. It has strong likenesses to Melbourne, though anyone from that city of orderly traffic might be pardoned for feeling confused among the tramlines in Cathedral Square.

Christchurch was having the first Royal Agricultural Show held since 1939, and in attending it I was making my first visit to such a show since visiting the Royal Counties Show near Christchurch (Hampshire) in 1938. Except for the trotting races, it might have been the same place. My first glass of southern hemisphere cider made me feel goodwill towards all men on this sunny afternoon, particularly to those interesting characters down for the show from the Canterbury high country, whose snow-tipped hills could be seen far away across the plains.

Westland

My desire to see some native bush now made me determined to take the trip through the Empire's longest railway tunnel to the west coast. An appeal to the R.T.O. once again produced me a seat on the

train, this time in the thrice-weekly express, and a friend kindly appeared at the station to provide me with a guide to the Arthurs Pass National Park. It was clear that the weather was not going to be good in the west for Christchurch was suffering the typically warm dry weather of the Nor'wester. As expected, rain began to descend on us as soon as we reached the inner edge of the plains at Springfield, so I could not see the glaciers I was anxiously looking out for as we climbed slowly up to Arthurs Pass Station. There are some compensations in seeing the forces of nature at work in mountainous country, but we were not pleased to find that the erosive powers of water had that day caused a washout and that our train was going to be held up by some trouble in the Otira Gorge. We had to wait while passengers in the eastbound train had their lunch in the refreshment rooms at Otira Station, and, alas, when we drew into the station ourselves there was not enough left. It was all very wet and depressing.

However we brightened more than did the heavens as the train moved on and eventually emerged from the Otira Gorge not more than an hour late. The scene was an indescribably wet one, and the northwesterly air mass provided me with an amazing contrast to the weather of our Milford Sound landfall. The Westport bus was waiting at Greymouth station, and I started off on a ride during which, because the rain was reducing visibility to one mile, I was forced to concentrate on the closer elements of the scene.

Some features of that bus ride were normal, the delivery of papers along the route and the cheery remarks of the driver, but most of the fifty-odd miles were to me quite full of abnormal interest. At last I was really in the New Zealand rainforest, and rimu and magnificent ferns grew in such profusion that in many cases the road was almost a tunnel. Soon however, and especially where there was a coastal platform, one noticed that much of the bush was second growth, and there was evidence of firing—a thing which seemed well nigh inconceivable on a day like this.

The settlement was rather odd, and one continually stopped opposite small wooden homes apparently planted down without rhyme or reason in the middle of second-growth bush. Not until my return along the road on the morrow did I manage to sort it all out in my mind, for I had not been fully briefed on the varied history of this coastland during the past hundred years.

Only one large dredge and a few sluices are now at work as tangible reminders that here, centred on Barrytown and Charlestown, was once a gold-mining community of near 40,000. Where on coastal platforms there is now nothing to be seen but wet bush, were once full-blooded communities linked together by a horse tram service. Desolation underlies this bush; only where the dredge has recently been at work, and the bush has not had time to hide it, can one see the ruination of the land where the coastal gravels have been sifted for gold.

The peculiar distribution of the present settlement is explained; and many of the present inhabited houses are simply those remaining buildings of the old mining communities which happened to be not too unfavourably placed to serve other and less spectacular needs. But even idle observation from the bus brought to light a few old 'characters' who were here because they had not completely escaped the glamour of the gold-rush days.

A Mining Community

More actively in evidence now than gold is a much more mundane mineral—coal. There is plenty of sub-bituminous coal in the Tertiary deposits here, but the seams are very faulted and warped. Although modern collieries exist inland, the workings along this coast road are on a very small scale, and small mines and opencast workings keep coming into view through the dripping undergrowth of fern-clad gullies. Lorries stagger out of muddy byways to take this coal to Greymouth or Westport. A few public houses remain of the hundreds which at one time catered for the gold miners here, and those which remain rejoice in such names as *All Nations Hotel* and *Europe Hotel*—to name but two which stamped themselves on my memory.

Back in Greymouth, I managed to reserve standing space in the railcar for Christchurch and went to look at the ships bar-bound in the harbour on account of the northwesterly swell. I and a representative of the *Grey River Argus* stood in the rain and watched the bloated body of a dead cow rising and falling as it passed the swell coming up across the bar and challenging the torrent of water flowing down the river. My companion assured me that dead cows were not a normal feature of Greymouth Harbour and that he had in fact never seen one there before.

Sunset in the Otira Gorge brought with it a slight lifting of the

clouds, and from the railcar I did have the satisfaction of seeing some alpine peaks, and some glaciers and icefalls, among the trees.

Finale and Farewell

The *Newfoundland* was now at Port Lyttelton but as she had to call at Wellington for fuel the next day, I was able to accept the offer of a lift in a R.N.Z.A.F. Dakota to Paraparaumu, and thus to have a quick glance at the dominion's capital. The latter lived up to its draughty reputation, but the wind was balmy enough until the cruiser had passed out of the harbour and turned into Cook Strait. We gradually drew out of sight of land, and I was left with one final regret that I had been able to see nothing of Nelson and the Marlborough Sounds.

First impressions are not always very sound, but they are always vivid. Since moreover in a busy world, judgments have so often to be made on first impressions, it is of interest for folk to record them. My own impressions of New Zealand were planted in a topsoil formed by eighteen months of service with Australia as my base. First impressions of Australia had faded, and England was distant to me in time as well as space. When I had first set foot in Australia I had been away from England almost continuously for five years, and it seemed like coming home, but though I am far from being the first to say it, it is probably worth recording that I found New Zealand even more like home.

After being familiar with Australia's spacious build, it is a strange sensation slowly to reconcile oneself to the finely-knit variety of New Zealand, where a mere fifty miles takes one not only from one morphologic province to another but into an entirely different climate—a land of 'samples' with variety even more pronounced than the British Isles. All this seems to be reflected in human reactions. It is not merely flattery to say that the New Zealander seems superficially more sure of himself than the Australian. The next half century will provide an enormously interesting spectacle to watch as New Zealand and Australia unfold their diverging futures.

THE FRUIT-GROWING INDUSTRY OF NELSON

N. J. ADAMSON

FOR MANY YEARS Nelson has held pride of place in New Zealand as a fruit-growing district more particularly on account of its extensive apple-growing industry and its major share of export shipments. Nelson is usually associated with sunshine and apples; and this is fully justified when facts and figures concerning apple production and sunshine records are examined.

Although the province is known more as a centre of apple growing it holds a unique position in New Zealand agriculture as it is also the centre of commercial production of hops and tobacco. Other horticultural crops are also grown extensively, particularly tomatoes, both outdoor and under glass, small fruits and peas for canning. The production of all these crops is confined to a small area in Waimea County and mostly within a distance of forty miles from the city of Nelson.

Climate is an important contributory factor in the success of all these industries. The sheltered position of Waimea County, its high proportion of sunshine and a well-distributed rainfall, make for very favourable conditions for cultivating fruit, tobacco, hops, tomatoes and market-garden crops. Sunshine frequently exceeds 2,500 hours per annum, while rainfall in the region varies from thirty-seven inches to more than fifty. At Nelson the precipitation totals thirty-seven inches, but at Motueka it is slightly over forty-five inches. Frosts are uncommon from the end of October until mid-April so that frost damage to horticultural crops is rare.

The development of some of the horticultural industries has brought about the intensive utilisation of land otherwise regarded as of low agricultural value. This applies particularly to the apple industry which is established mainly on the Moutere Hills where the majority of the orchards have been developed. The 'Moutere' soils which cover an extensive area in the centre of the Waimea County are shallow and in many places the clay subsoil is exposed. Prior to the arrival of Nelson settlers much of this land was in beech forest, but it was burnt off and the land sown to English grasses and clovers, but rapid deterioration resulted and large areas reverted to fern and manuka. Today, at the northern end of the Moutere Hills, facing Tasman Bay, apple orchards

have been developed and have proved a profitable utilisation of land that previously was regarded as of little value except for afforestation purposes.

Age and Acreage

Although fruit growing in some form had been undertaken in the Nelson Province, mainly in more fertile areas, for many years, the planting of apples for export did not assume major proportions until about 1911 when the Moutere Hills came into prominence as potential lands for that purpose. Large areas were taken up by syndicates, subdivided and sold for apple growing, and extensive planting was undertaken from 1911 to 1916, when, owing to the continuation of the war, extensive planting was discontinued. It is mainly from the plantings of those years that present production is derived. During such a boom there was inevitably much ill-advised planting, besides which many absentee owners found that the development up to full bearing took longer and was more costly than had been calculated, so that many young orchards were not brought to maturity. The total orchard area reached between seven and eight thousand acres, but gradually declined over a period of years until there are now less than 3,800 acres. Although many acres have been lost, production has not been reduced proportionately, but has been maintained at a higher level per acre on the remaining orchards which have benefited from better management and from the application of knowledge gained over the years as a result of research and experience. In early years, lack of knowledge of soil requirements and lack of money with which to purchase lime and fertilisers and seed for cover crops, meant that there was not secured the rapid tree growth now obtained. The relatively poor growth and slow development of trees on Moutere soils was the major problem of the developmental period.

The manurial treatment of the orchards was one of the first studies made by the Cawthron Institute on behalf of the fruit growers and it was quickly shown that the soil was lacking in lime, phosphate, organic matter and nitrogen and that a manurial programme must provide for all these deficiencies in order to ensure good tree growth. As a result of further research and long term manurial trials carried out by the Institute and on the Research Orchard of the Department of Scientific and Industrial Research at Appleby it has been possible to prescribe accurately for average orchards. An annual application of

three pounds of superphosphate, one pound of muriate or sulphate of potash and two pounds of dried blood or sulphate of ammonia for each tree, or an equivalent mixture, has become the standard fertiliser dressing. Such a fertiliser application, with occasional limings and growing of cover crops for ploughing or discing in, is the normal practice. Clean cultivation is carried out from spring until the end of January. Further problems of boron and magnesium deficiency were encountered later but were overcome as a result of investigation.

Nelson orchards were planted mainly to produce fruit for export. For many years satisfactory markets were found in the United Kingdom, on the Continent, in South America and to a less extent in Canada. With the outbreak of war in 1939, the export of fruit was suddenly halted and was resumed only in 1948. In the intervening years the industry was assisted by the expansion of markets in New Zealand. A compulsory marketing scheme not only kept the industry alive over a difficult period but led to well-organised marketing of the whole crop using both export and local markets.

Distribution of Orchards

For convenience of general administration and organisation, Nelson is divided into three fruit-growing areas each served by a port which has become the inspection and assembly point. The separate areas are: 1. Nelson comprising the districts of Stoke, Richmond, the Waimeas, Appleby and Redwoods Valley, which ship through Port Nelson; 2. the Central District which includes the coastal strip of the Moutere Hills, the Tasman settlement, Mahana, Bronte and other subdivisions, and has the Port of Mapua as its centre and point of shipment; 3. Motueka which is a focal point for the fruit-growing districts of Riwaka, Braeburn and Lower Moutere with Port Motueka as the assembly, inspection and shipping point.

The peak year for Nelson fruit export was 1934 when over one million cases of apples and pears were shipped. At that time the total crop was estimated at 1,300,000 cases, including fruit sold on New Zealand markets which was not under any form of control at that time and its volume was difficult to ascertain. Production receded during World War II through lack of labour and shortage of fertilisers.

Production: Now and In Future

The industry has been revitalised in the postwar years. The marketing scheme has given growers an assured return enabling them to save

something towards replacement and improvement of equipment. Fertiliser supply has improved and younger men—rehabilitated ex-servicemen and, in many cases, sons of orchardists—have taken over. The result is more intensive cultivation, more efficient spraying and a general improvement in tree growth and cropping capacity. It is heartening to find in 1948 that production from a much-reduced acreage reached a new peak. In that year the yield was 1,425,000 cases of apples and pears which is remarkable in view of the age of the majority of trees. To harvest and deliver such an amount of fruit in a relatively short period requires the employment of much seasonal labour and the fullest utilisation of the transport facilities in the province. From February to mid-May fruit-laden trucks are a common sight on the roads, but a more impressive idea of fruit traffic is gained near the three ports towards which the fruit is converging for inspection, sorting and from which it is despatched either by steamer to North Island ports, or by road to Blenheim for railing south.

Although much work is done by horticultural officers in the field directing harvesting, instructing in grading and packing and exercising a general supervision, a careful inspection of every consignment is carried out at the ports by a team of inspectors who ensure that fruit is in a suitable condition for the purpose required. Following inspection and acceptance, the fruit passes into the hands of officers of the Marketing Department who direct its discharge into wharf sheds for tallying, sorting and final despatch. Coastal steamers are used for carrying fruit cargoes from Nelson and the Tasman Bay ports so that it is a familiar sight to see fruit being loaded into well-known vessels of the Anchor Company's fleet at these ports during the fruit season. Before World War II a proportion at least of Nelson export fruit was loaded direct on to overseas vessels, but so far the shipping programme of postwar years has not allowed of this; but Nelson growers keep on hoping that these privileges will be restored and savings in freight charges will be effected and so assist the industry.

Nelson, as previously pointed out, is essentially a centre of horticultural industries. Its prosperity is largely dependent on the continued success of apple growing. Apple trees have, like all other plants, a limited life. Replacements become necessary and in many cases, particularly with certain varieties, such replacements are now overdue. A vigorous policy of replanting is being pursued by the growers and use is being made of more vigorous tree stocks so that in a reasonable

time there is every likelihood that present levels of production will not only be maintained but exceeded. In future years, therefore, the association of the name of Nelson with sunshine and apples should not lose any significance.

PHOTOGEOGRAPHY

A PICTORIAL SURVEY OF NEW ZEALAND

4. APPLES FROM NELSON

Fig. 1. *Tasman Bay.* *Photo*: John Pas

Fig. 2. *Annesbrook Orchard.* *Photo*: John Pas

Fig. 3.
Apple Orcha
Moutere Hil

Photo: W. Wi

Fig. 4.
Spraying.

Photo:
A. R. Kingsfor

Fig. 5.
Picking.

Photo:
A. R. Kingsfor

6.
ding
Packing.
o: W. Wilson

g. 7.
sembly
pot.
oto: W. Wilson

g. 8.
spection.
oto: W. Wilson

Figs. 9 and 10.
Markets: apples for New Zealand schools and for export.

Photos: John Pascoe

11. *Other crops—tobacco, tomatoes, hops, peas, raspberries, etc.—Riwaka.*

Photo: N.Z. Herald

NEW ZEALAND GEOGRAPHICAL SOCIETY: BRANCH AFFAIRS

Canterbury Branch

Officers for 1949 are— *President*: Mr. W. S. MacGibbon
Vice-Presidents: Mr. J. Acland, Dr. G. Jobberns, Mr. J. L. Hewland
Chairman: Mr. H. J. Critchfield
Secretary-Treasurer: Mr. A. V. Barley *Hon. Auditor*: Mr. W. Rosenberg
Recorder: Mr. M. McCaskill
Committee: Miss N. Clark, Messrs. A. C. Pitcaithly, Y. T. Shand, H. M. Sweney

Meetings of the Canterbury Branch were held as follows:—March, Dr. Robert Cushman Murphy: 'A Naturalist Looks at New Zealand', illustrated by colour films of outstanding interest; April, Dr. G. Jobberns: 'Trans-Tasman Air Service'; June, Mr. W. S. MacGibbon: 'Town Planning in the Growth of Christchurch'; July, Mr. H. J. Critchfield: 'Unknown Idaho'; August, Dr. C. A. Cotton: 'The Lyttelton Harbour Problem'; September, Honours Students' Papers; October, Annual General Meeting and Brains Trust Discussion. A film evening was held in May when the films shown were 'Twenty-four Square Miles' and 'Oil of Peru'.

The Geography Teachers' Group has continued with its useful work. Reports were given on the refresher courses at Oamaru and New Plymouth. A list of the basic requirements for the teaching of geography was prepared and sent on to the appropriate authorities. Recommendations to the School Publications Branch were drafted and a decision was made to prepare a booklet for primary schools on the 'Story of Christchurch' in time for the Centennial.

Wellington Branch

Officers for 1949 are— *President*: Dr. R. A. Falla
Vice-Presidents: Mr. D. I. Macdonald, Mr. R. J. Waghorn
Chairman: Mr. N. E. Dalmer
Secretary: Miss J. K. Finney *Treasurer*: Miss B. Page
Publicity Officer: Mr. D. W. McKenzie *Hon. Auditor*: Mr. T. L. James
Committee: Mrs. S. Turner, Miss V. Anderson, Mr. G. Anderson, Mr. R. P. Graham
Council Delegate: Miss J. K. Finney

The following lecture programme was presented during the year:—

'A Polynesian Atoll in Micronesia' by Sir Peter Buck; 'Life in Nigeria' by Mr. J. Wright; 'Places and People, Pants and Paranoia in the United States' by Mr. W. J. Scott; 'The Ancient Bird Life of New Zealand—Recent Researches' by Dr. R. A. Falla; 'The Outline of the Universe' by Mr. I. L. Thomsen; 'Peoples and Problems of Malaya' by Mr. R. G. Lister; and 'Soils and Man' by Mr. N. H. Taylor. It is intended to conclude the 1949 session with a Members' Brains Trust. In addition to the lecture programme, four film evenings have been shown.

The first meeting of the branch was held in association with the Wellington Branch of the Polynesian Society, and at the Annual General Meeting of the New Zealand Geographical Society. Dr. R. A. Falla addressed a large audience and showed coloured films of the notornis.

Auckland Branch

Officers for 1949 are— *President:* Professor H. R. Rodwell
Vice-Presidents: Sir Albert Ellis, Dr. G. Blake-Palmer, Professor J. A. Bartrum
Professor V. J. Chapman
Chairman: Mr. R. A. Watson
Deputy Chairman: Mr. N. Pountney
Hon. Secretary: Mr. R. G. Lister *Hon. Treasurer*: Mr. R. M. J. MacDermott
Hon. Auditor: Mr. J. K. Bedbrook *Recorder*: Mr. L. Lucena
Committee: Miss I. Kirk, Mr. A. R. Harvey, Mr. A. L. Ferguson, Mr. G. G. Harvey, Mr. J. Martin

The varied programme of lectures, film evenings and panel discussion meetings, dealing mainly with New Zealand and its Pacific neighbourhood, was supplemented during the early months of the session by special meetings. Professor Wallace W. Atwood, on 'The Rocky Mountains'; Dr. Robert Cushman Murphy, on 'A Naturalist looks at New Zealand'; and Dr. Olaus J. Murie, on 'Wilderness Recreation'; presented the branch with memorable evenings.

Monthly lectures in the normal programme were presented as follows: Mr. W. McGregor, 'Village Life in New Britain'; Professor Kenneth B. Cumberland, 'New Zealand and the Islands of the Pacific'; Mr. F. Jones, 'Auckland and its Town-Planning Problems'; Mr. L. Withers, 'The Hydroelectric Development of New Zealand'; Mr. A. W. Smith, 'Altitudinal Distribution of Industries in the Colorado Rocky Mountains'. A Brains Trust evening in August and a panel discussion on 'Trusteeship in the South Pacific' were other highlights.

This year, for the first time, the branch was able to hear from the students themselves the outlines of their M.A. theses. The Geography Teachers' Association held a series of meetings during the session, dealing with 'Mapwork in School' and 'Textbooks and recently published material', and discussions were held on other topics.

Otago Branch

Officers for 1949 are— *President*: Mr. B. J. Garnier
Past-President: Dr. B. H. Howard
Vice-Presidents: Mr. P. G. Connolly, M.P., Mr. A. H. Payne, Mr. G. Simpson
Chairman: Mr. W. E. Earnshaw
Hon. Secretary-Treasurer: Mr. W. F. Reid *Hon. Auditor*: Mr. G. S. Kirby
Committee: Miss R. T. Coxhead, Miss D. M. Martyn, Miss L. C. Voller, Mr. N. Dew, Mr. R. H. Greenwood, Mr. W. R. Mayhew, Mr. D. Sage

So far this year this branch has had some excellent meetings, the attendance at one of them being somewhat marred by heavy snow. Mr. R. H. Greenwood, recently appointed Lecturer in Geography at Otago University, spoke on 'Crops, Coal and Cities', a retrospect on the geography of Britain at the April meeting. Mr. H. J. Critchfield, now well known to many New Zealanders, gave a delightful and valuable address with excellent slides on Alaska.

A feature of the year's activities has been the holding of joint meetings with kindred societies. So far the branch has cooperated with the Otago Historical Society and the Otago Branch of the Royal Society, as well as always issuing invitations to special meetings to other interested bodies.

GEOGRAPHIC NOTEBOOK

CONTRIBUTORS TO THIS ISSUE. The first part of Volume V (April 1949) contained a general survey of the agricultural problems and prospects of island territories in the Pacific. In this issue we are able to present articles which provide specific illustration of the more general matters discussed in the last issue. The historical and contemporary study of agriculture in the British Crown Colony of Fiji is the work of Mr. Cedric Harvey, Director of Agriculture, Suva, Fiji. With experience of agricultural research and administration in Fiji, the West Indies and East Africa, Mr. Harvey writes with great authority.

The *New Zealand Geographer* has frequently drawn attention to the work of anthropologists, but Professor William Bascom's description of subsistence agriculture on Ponape in the Carolines, part of the recently-constituted United States Trust Territories of the Pacific, is the first article written by an anthropologist that we have had the privilege of publishing. Dr. Bascom is Professor of Anthropology in the College of Liberal Arts, Northwestern University, Evanston, Illinois, U.S.A. The papers by Mr. Harvey and Dr. Bascom were both read before the Seventh Pacific Science Congress in New Zealand earlier this year.

Of three articles on New Zealand, one on local geomorphological problems is by a world authority in his field. Professor C. A. Cotton of Victoria University College, Wellington, needs no introduction. Mr. N. J. Adamson is Horticultural Superintendent, Department of Agriculture, Nelson. The third article on New Zealand is from the pen of an overseas visitor. It comprises the impressions of a visiting geographer. Mr. F. H. W. Green was formerly Lecturer in Geography, University College, Southampton, and visited New Zealand in 1945 whilst serving with the Royal Navy. He is now on the staff of the Ministry of Town and Country Planning.

Among contributors of reviews and of other short notices and comments in this issue are: Professor G. Jobberns, Canterbury University College; Mr. Roger Duff, Director, Canterbury Museum, Christchurch; Dr. H. E. Annett, Animal Research Station, Ruakura; Mr. P. W. Smallfield, Director, Extension Division, Department of Agriculture, Wellington; Mr. A. W. Smith and Mr. L. L. Pownall, Auckland University College, Auckland; Mr. H. J. Critchfield and Mr. Murray McCaskill, Canterbury University College, Christchurch; Mr. B. J. Garnier and Mr. R. H. Greenwood, University of Otago, Dunedin; Professor V. J. Chapman, and Mr. John Reid, Auckland University College, Auckland; Mr. H. I. Sinclair, Dunedin; and the editorial staff.

GEOGRAPHY AND GEOGRAPHERS IN THE UNIVERSITY. A note in a previous number of this journal (Vol. III, No. 1) recorded developments in University Departments of Geography to that date. Since then the teaching of geography has advanced to M.A. and Honours at Auckland University College, to Stage II at Victoria University College, Wellington, and to Stage III in the University of Otago. The successful establishment of geography at Auckland has been crowned by the appointment of Dr. Kenneth B. Cumberland as Professor occupying the Chair established in 1948. In the decade since Dr. Cumberland came from University College, London, to take up the post of Lecturer in Geography at Canterbury

University College, he has made a many-sided contribution to university life and work, and in his appointment as Professor of Geography in the University of New Zealand he will have the good wishes of the New Zealand Geographical Society. Other appointments at Auckland are those of Mr. A. W. Smith, M.A., (University of Colorado), and Mr. L. L. Pownall, M.A., who has lately been on the staff of the Teachers' College at Ardmore. Mr. Pownall, a graduate of Canterbury University College, held the Whitbeck Fellowship at the University of Wisconsin, returning to New Zealand early in 1948. Mr. Smith is a Visiting Lecturer who, while teaching for two years at Auckland, hopes to complete his dissertation for his Ph.D. degree. His army service took him over extensive areas of the Pacific.

Another Visiting Lecturer is Mr. Howard J. Critchfield, M.A., from the University of Washington, whose course as a student there had been interrupted by service in the meteorological section of the U.S. Army Air Force, much of which was spent in Alaska. Mr. Critchfield, is working at Canterbury University College on material for his Ph.D. degree which he expects to complete on his return to Seattle in August 1950. Also at Christchurch as Visiting Lecturer is Dr. Donald J. Patton, a distinguished graduate of Harvard University. Dr. Patton's war service has given him first hand experience of Britain and several European countries, and he has also travelled in South America. We welcome this opportunity of securing these very competent young American geographers and hope the experience will be as much to their benefit as it is to ours.

Mr. Graham Lawton, M.A. (Oxon.) who for two years had been Senior Lecturer in Geography at Canterbury University College, left in October 1947 to take up his professorial appointment in the Department of Geography in the University of Washington at Seattle. Two Canterbury students, Messrs. B. H. Farrell and Keith W. Thomson, have gone there at his invitation to take up Teaching Fellowships while working for the M.A. degree which they both expect to complete by August of this year. Mr. Farrell will then teach for a year in the Southern Methodist University at Dallas, Texas. During 1948 Dr. R. O. Buchanan, Reader in Geography at University College, London, occupied the post of Visiting Lecturer at Canterbury University College. Since his return to England Dr. Buchanan has been invited to occupy, and has accepted, the Chair of Economic Geography at the London School of Economics. This visit enabled hosts of Dr. Buchanan's old New Zealand friends to renew acquaintance with him and it was a most stimulating and useful experience for the college generally. He addressed meetings of all four branches of the society during his stay in this country. Junior members of the staff of the Department of Geography at Canterbury University College are Messrs. Murray McCaskill and A. J. Rose, both of whom graduated recently with First Class Honours.

The staff of the Department of Geography at University of Otago was enlarged in 1947 by the appointment of Mr. R. H. Greenwood, M.A. (Cantab.) as Lecturer in Geography. This year Mr. A. D. Tweedie, B.A., has taken up an interim appointment as Junior Lecturer.

Of interest to university students of geography is the recent decision of the University of New Zealand to permit them to take the B.Sc. and M.Sc. in the subject. This will enable those wishing to specialise in the physical aspects of the subject and in biogeography to correlate their undergraduate courses more fully with the natural

sciences. It is likely, however, that the majority of students preparing themselves for the teaching profession will continue to take the subject for the Arts degree thus enabling them to include English and History in degree courses that will adequately equip them for teaching the social studies in our schools.—G. JOBBERNS.

M.A. THESES IN GEOGRAPHY. In previous issues of the *New Zealand Geographer* a record has been made of the titles of theses presented for the M.A. Degree in Geography of the University of New Zealand. The theses listed below were presented in 1948 by students of Canterbury University College.

The Te Awaiti Whaling Station, Cook Strait, Doreen R. Caygill;
The Starborough Estate, Marlborough, J. F. Collins;
Kaikoura—the Town and its Tributary Region, J. T. Dykes;
Hawkes Bay—a Comparative Study of Napier and Hastings and their Hinterlands, W. Guthrie;
The Longbeach Estate, Mid-Canterbury, J. W. Kelly;
The Development of Communications between Canterbury and Marlborough, D. J. MacLachlan;
The Hutt Valley: a Geographic Reconnaissance, J. B. McWilliams.
The Takaka Valley, A. J. Rose;
Picton, its Site, Form and Function, Betty Toynbee;
The Waimate Run, South Canterbury, N. H. Whatman;
The Port of Timaru, R. H. Wheeler.

THE RABBIT PROBLEM. Although numerous observers over the past eighty years have pointed to the serious economic loss caused by rabbit infestation in New Zealand, it is surprising that control measures have proved to be so ineffective and that field research into the complicated problems of rabbit ecology has been so long delayed. Rabbits were first introduced to the country in 1838 but failed to become acclimatised. There were further introductions in the 1860's and by the mid-1870's they had spread at such a phenomenal rate as to threaten the very existence of the pastoral industry in parts of Southland and Otago and aroused grave concern elsewhere. Despite the mass of legislation subsequent to 1876, rabbit infestation continues to be one of the more serious and urgent land problems of the dominion. The war aggravated the problem. In the absence of labour, materials and a comprehensive policy of control, many areas previously free of rabbits have become badly infested. The wartime demand for skins appears to have encouraged the practice of rabbit 'farming' especially in some of the lower rainfall districts of the South Island.

According to a statement issued by the Department of Scientific and Industrial Research, approximately twenty million rabbits were destroyed in 1947. Five-sixths of these were exported as skins and carcases, increasing the value of our export trade by more than £1,000,000. However, it is believed that only a third of the rabbit population (estimated as oscillating between forty and fifty millions) is destroyed each year and this appears to do little more than keep a check on their numbers. The food consumption of the rabbit is out of all proportion to its size and although the breeding ewe is about thirty-eight times the weight of the average rabbit, ten rabbits may eat as much as one ewe. The annual loss in sheep-carrying capacity is estimated to be at

least £3,000,000 and possibly as much as £5,000,000. In addition there are losses more difficult to assess, such as the damage to young plantations, the fouling of pastures, the increase in weeds due to selective feeding and the part played by the rabbit in accelerated erosion. A more insidious loss has been the reduction of native bird life due to the laying of non-selective rabbit poison and to the ill-advised importation of the stoat and other vermin as a means of rabbit control.

There are a number of indications, however, of an increasing awareness of the problem in official circles and a more resolute policy of rabbit destruction is envisaged. In 1947 legislation was passed establishing a Rabbit Destruction Council whose duties, among others, are to 'devise and promote measures for the purpose of destroying rabbits', to 'coordinate and generally guide and supervise the activities of Rabbit Boards', and to recommend rates to be levied on rabbit skins. Within twelve months of the establishment of the council a further five million acres have been brought under the control of Rabbit Boards as part of a policy to give complete coverage of all infested parts of the country and steps have been taken to prevent reinfestation of areas now rabbit-free. Of the 108 existing Rabbit Boards forty were merely inspectorial in function, and all but three of these have been required to adopt a killer policy. Current policy aims at the complete extermination of the rabbit; reduction and control are recognised as palliatives rather than as solutions to the problem. To this end the council hopes to decommercialise the rabbit trade by means of a levy (at present twenty percent) on all skins. Only when it becomes unprofitable to 'farm' the rabbit can complete extermination be considered feasible.

Research is to go hand in hand with legislative measures and the Animal Ecology Section of the D.S.I.R. has given priority to field studies on the habits, modes of life and environmental relations of the rabbit. But the department warns that the problems are so complex that practical applications of the new research cannot be expected for some time. The heavily-infested areas are widely distributed and include parts of Southland, Otago, the Mackenzie Basin and Waitaki Valley, Marlborough, central Hawkes Bay, the Taupo district and North Auckland. Since these embrace a wide variety of climates, soil types, plant associations and farming practices it would seem essential that research work and destruction measures be approached on a regional basis before complete elimination of the rabbit pest is achieved.

—MURRAY MCCASKILL.

RAIL TRANSPORT IN NEW ZEALAND. It is a generally-accepted truth that railway operation in a 'new' country under normal circumstances shows a deficit in revenue. The railways must be built to serve both the needs of the community and the national interest; they must operate efficient services in those parts of the country which are closely settled, but at the same time they constitute the means whereby marginal land and less densely populated areas can be developed. Thirdly the railway has a strategic importance that is often overlooked. It is for these reasons, among others, that railways in such territories as northern Canada, Australia and New Zealand must be run by the government if they are adequately to fulfil their essential functions.

The [N.Z.] *Railways Statement* for 1948 provides no exception to these axioms, for losses on the whole undertaking amounted to £640,025 during the year, despite a

higher total revenue. It is significant that whereas there was a decrease in passenger receipts of 17.4 percent, freight revenue increased by 17.8 percent and the tonnage of goods moved was higher than in any previous year. This is an indication of the return to more normal peacetime conditions in New Zealand. Agriculture, industry and trade are losing something of their wartime artificiality, and by the same token, long-distance passenger traffic on the railways now comprises, not service personnel and those who were forced to travel by train because of the shortage of petrol, but people who cannot afford to travel by private car or who cannot afford the time taken by service car. Rail travel must be made more attractive if the loss in passenger revenue is not to increase; there must be greater comfort, faster services and the more convenient timing and flexibility which would ensue from such improvements. That the department is thinking of restaurant cars and of electrification, and perhaps of the reinstitution of the daylight limited express between Auckland and Wellington, is evidence of a move in this direction.

Nevertheless the problems of railway operation in New Zealand do not admit of easy solution. The nature of the terrain in the central parts of the North and South Islands is such that heavy gradients are the rule, particularly on the North Island main line between Te Kuiti and Marton, and running costs per locomotive-mile are evidence of this. The report shows that the average costs in the North Island are 47.5 percent greater than those on the South Island lines, and that by far the greatest proportion of these costs is to be ascribed to fuel. This points to the second problem in railway operation in New Zealand—the lack of suitable coal.

To eke out resources and to keep down expenditure, soft coal must be mixed with hard, with a resultant loss in locomotive efficiency, so that it is the dearth of hard coal that is ultimately responsible for many of the difficulties of working, especially in the North Island where the proportion of soft coal used during 1948 was as high as fifty-eight percent. An attempt was made to remedy matters by importing American coal at a cost of over £10 per ton, about four times the price of New Zealand hard coal. The use of this imported coal was confined to the North Island system and goes a long way to explain the higher costs per locomotive-mile. In the South Island New Zealand hard coal was more readily available. Nevertheless, increased freight rates and higher passenger fares, or a loss on railway operation, can be attributed in some measure to the underproduction of coal in New Zealand, in particular to the decreasing per capita output in the mines.

The conversion of thirty-four locomotives to oil-burning was another attempt to solve the problem, but the cost of oil doubled during the year. The fuel costs per locomotive-mile are thus remarkably interesting; in the North Island for coal-burners, 33.35 pence, and for oil-burners, 66.63 pence; in the South Island 10.38 pence. No oil-burning locomotives operated in the South Island. The average cost of electric traction, as a fuel equivalent, was 9.19 pence per locomotive-mile in 1948. The report provides insufficient information for a comparison of steam and electric traction costs as a whole, but the figures supplied do point to a greater efficiency of working with electric locomotives. The electrification of the North Island main line between Auckland and Wellington may therefore be a desirable feature in future railway development, but firstly there must be sufficient power available and secondly the money must be found for overhead equipment on some 400 miles of track. One

wonders how far, despite the cost of imported oil, diesel-electric traction would be the better alternative.

Yet to the geographer the sections of the *Railways Statement* of the most direct interest are the returns of traffic and revenue for each station and the classification of goods traffic by commodities. Three-quarters of the total revenue in 1948 was derived from the transport of goods, and in this respect particularly the railways play a significant part in the country's economy. Coal mined in New Zealand constituted the largest single item of tonnage carried (22 percent), and it is a striking commentary on the location of the mines and the dispersal of the population that the average haul for soft coal was 127 miles, and for hard coal seventy-four miles. A similar point is brought out in the statement that the average haul for cement was 166 miles, and for timber grown in New Zealand 150 miles. By contrast frozen meat was carried forty-one miles, a reflection of the coastal location of most freezing works. The longest average hauls were for fish and for fruit and vegetables, 172 and 203 miles respectively, indicating production in a few special centres. Fertilisers and agricultural lime bulked largely in the tonnage carried, together making up sixteen percent, whilst the compound figure for all farm produce was 25.5 percent—a grand total of more than two-fifths and sufficient evidence that the railways are vital to New Zealand's primary industry.

An examination of the station returns shows that of all the cattle and calves carried by the railways in 1948, eighty-eight percent were despatched through North Island stations. Fifty-eight percent of the sheep and pigs were likewise transported over the northern system. In both the North and South Islands one in every three of these animals in New Zealand was at some stage carried by rail. That the final destination of much of the stock is the meat export works is emphasised by the fact that of the total numbers railed in the dominion three-quarters of the cattle and calves were consigned to stations serving the freezing works (seventy percent in the North Island and five percent in the South). The corresponding figures for sheep and pigs were two-thirds, (thirty-nine and twenty-eight percent). The importance of the Auckland group of freezing works is seen in that at Penrose and Otahuhu were unloaded one-third of the cattle and calves and one-fifth of the sheep and pigs transported by rail in New Zealand.

The only other specific item of freight for which figures are given is timber. In the North Island, Putaruru, National Park, Taumarunui, Ongarue, Rotorua and Mamaku despatched the greatest quantities, and Ngahere, Hokitika, Tuatapere and Ross in the South Island. In both islands the main receiving centres were the great cities, with Auckland at the head of the list by a considerable margin. The amount of timber passing through Putaruru was not far short of the combined total of the four South Island stations named, and whereas the latter were responsible for a third of the total timber sent by rail in the South Island, the aggregate of the first five North Island stations was but one-eighth of the total despatched in that island.

Thus the railways are endeavouring to meet their responsibilities despite problems of labour and material and despite congestion in goods yards and on the wharves. The Minister of Railways said when presenting his statement, 'It is essential to pay full regard to the railways as a stabilising factor in the dominion's economy, and the country may rest assured that every effort is being made to provide a modern railway

service at the lowest possible cost, for it is obvious that the railways must be regarded as a prime function of industry and must be used to the best advantage generally in the public interest'. The minister may rest assured that the public is only too acutely aware of the difficulties of railway operation.

OBITUARY. By the death of Professor J. A. Bartrum the New Zealand Geographical Society has lost a very good friend to whom it owes much. In the days when geography as a university study was attached to geology he was consistently anxious to promote its development, but believed that it would not make real progress until it stood on its own feet with independent university departments. He had tried in his own Department of Geology the giving of instruction to first-year students but found this to be such a tax on his resources of accommodation and staff as to confirm his belief that justice could not be done to the subject in these circumstances. Therefore both in Auckland University College and on the Academic Board of the New Zealand University he was ready at all times with his help in promoting the recognition and establishment of geography in the university.

He was equally enthusiastic in the early days of the formation of the New Zealand Geographical Society and his help in the foundation of the Auckland Branch, of which he was Vice-President at the time of his death, was invaluable. It is fitting that our appreciation of this friendly cooperation should be placed on record. He also watched with keen and friendly interest the growth to full stature of the new Department of Geography in Auckland University College.

Professor Bartrum's own work lay within the field of geology, though in many of his published papers, especially on the physiography of the Auckland Province, will be found indispensable source material for students of geography. By setting rigid standards for his own students and himself he built a fine reputation for his Department of Geology. In spite of his physical disabilities his energy was prodigious; he never spared himself and there can be no doubt that to this his untimely death was largely due. At the A.N.Z.A.A.S. meeting in Hobart in January of this year he participated fully in the work of Section C, and on his return to Auckland plunged vigorously into all the activities of the Seventh Pacific Science Congress. After this, however, his health declined rapidly and he died at Rotorua on 7 June 1949.

The New Zealand Geographical Society has lost one of its best friends and most valued members.

With deep regret New Zealand geographers learned also of the death on 24 July 1949 of Dr. Wallace W. Atwood. Dr. Atwood attended the Seventh Pacific Science Congress and subsequently made an extensive lecture tour of New Zealand and its university colleges. With his death there passed from the scene an eminent physiographer who early realised the significance and value of geography as a university subject and who founded the first graduate school of geography in the United States. Wallace W. Atwood will indeed be sadly missed.

IN OUR CONTEMPORARIES . . .

1. *In New Zealand Journals* . . .

Better Pastures, Increased Production

INTENSIVE GRASSLAND FARMING IN NEW ZEALAND: E. Bruce Levy, *Grasslands*, Bulletin No. 1, March 1949.

SPECIAL PURPOSE PASTURES IN INTENSIVE GRASSLAND FARMING: E. Bruce Levy and P. D. Sears, [Lincoln College] *Rural Education Bulletin* Vol. 4, No. 4, May 1949.

The work of the Grasslands Division has been of such enormous value to the dominion that one welcomes the appearance of the first of a series of bulletins written by specialists attached to the division, and it is appropriate that Bulletin No. 1 should be the work of its distinguished head. This publication is an advance copy of a paper which Mr. Levy will present at the Fifth International Grassland Conference in the Netherlands. Teachers and students of geography will discover in these specialist essays much useful material for regional studies.

European farmers will find it hard to believe Mr. Levy's statements of actual and theoretical production from grassland farms in New Zealand. He stresses the need for efficient grazing management and for the saving of surplus grass as hay and ensilage. Clover being the key plant in the pasture, he insists on the need for the ample phosphate application which is of such prime importance for the growth of this plant. The clover in turn supplies the nitrogen so necessary for grass growth. He deals with the more recent work of the Grasslands Division on the breeding of western wolths, Italian, short rotation and long rotation ryegrasses. Each of these is recommended for a specific purpose and forms the basis of special purpose pastures. The perennial ryegrass-white clover type of pasture is termed the general purpose pasture. Mr. Levy suggests that half the farm should be in general purpose and half in special purpose pastures, and gives recommendations for seed mixtures.

'Special Purpose Pastures in Intensive Grassland Farming' elaborates in more detail certain aspects of Mr. Levy's other paper. A very valuable section deals with the management and utilisation of the general and special purpose pastures. This is such a clear statement that it could usefully be issued as a separate pamphlet and widely published. Hidden away as it is as one section of a fairly long article few are likely to notice it. Many farmers have been disappointed with special purpose pastures because they have not understood that they must be spelled at certain periods. When grazed in breaks in July and August the general ryegrass-white clover pasture can be rested to allow it to make good growth in spring, when both types of pasture can be grazed. The need for spelling the special purpose pasture in November and December is stressed in order to give the red clover a chance to grow and to enable the short rotation ryegrass to seed. After Christmas these can be grazed up to mid-March, when they can be rested to produce winter and early spring feed.

Many imagine that controlled grazing is a simple matter. However few farmers have learnt to control their existing permanent pastures to the best advantage. The inclusion of special purpose pastures will require even greater skill on the part of the farmer, and the full value of the work of Mr. Levy and his associates can never be realised without an intensive campaign to improve pasture management methods.

—H. E. Annett.

Beech Forests of Southern New Zealand

ECOLOGICAL INVESTIGATIONS IN THE *NOTHOFAGUS* FORESTS IN NEW ZEALAND: J. T. Holloway, *The New Zealand Journal of Forestry*, Vol. V, No. 5, 1948, pp. 401-410.

One of the most sorry results of a century of human occupance in New Zealand is the wholesale destruction of native forest and the creation of soil instability, with the land reverting to scrub and second growth, and producing tendencies to serious flooding and loss of water storage. In the paper under review, which was read at the Seventh Pacific Science Congress in Christchurch, Mr. Holloway presents a progress report on the *Nothofagus* forests of New Zealand 'in order that, so far as possible, management and conservation policy may be based upon a sound understanding of their ecology'.

A great variety of types of *Nothofagus* forest exists, covering a wide range of climatic conditions, but for purposes of convenience they can be divided into two groups: those associated with 'sub-continental climates' characterised by cold winters, hot summers, low rainfall and periodic droughts, and those found in regions of 'mountain climates' where summers are cool, short and wet, and winters cold and wet. This simple grouping, however, must not be allowed, as Mr. Holloway rightly stresses, to cover up the range of forest types under a wide variety of climatic conditions which actually exist. Another feature of the forest, which leads to abnormal associations, is that *Nothofagus* readily pioneers the occupation of new ground. 'In this way many areas of *Nothofagus* forest of one or other species may exist within the climatic range of the podocarp forests or, alternatively, one *Nothofagus* species may pioneer an area essentially more suited to another.' These idiosyncratic tendencies make the cultivation of *Nothofagus* forest difficult and its proper care and management implies the development of a team of skilled specialist field officers.

The difficulties of management inherent in the nature of *Nothofagus* are increased in New Zealand by the amount of evidence which shows that the forests are not in a stable condition. 'Surveys of the forests of Western Southland suggest very strongly that major changes in species distribution are in progress. It appears that the changes in evidence are consequent upon a major climatic change in the recent past; and this change can only have been in the direction of increasing aridity inland, probably accompanied by a decrease in mean annual temperature. There followed a general retreat of the forests towards the coasts . . . . . Near the coasts the silver beech forest invades and replaces podocarp forest. Inland, the more xerophytic mountain beech forest replaces silver beech, only to be replaced in turn by scrublands and grasslands.' These changes were, however, by no means rapid. The major initial consequence of climatic alteration in the forest habitat was instability, and rapid alteration of vegetative type took place only if some disaster occurred. Fire is suggested as a cause of the rapid alteration which produced, not an expected successional phase of, for instance, subcontinental *Nothofagus* forest, but large areas of subclimax grassland. Subsequently unwise grazing has caused erosion which has led to semidesert conditions in places.

It is particularly interesting that the conclusions reached in this paper should coincide so well with those of J. D. Raeside, whose paper 'Some post-glacial climatic changes in Canterbury and their effect on soil formation' in *Transactions and Proceedings*

of the *Royal Society of New Zealand*, Vol. 77, 1948, pp. 153-171, was reviewed in the *New Zealand Geographer*, Vol. IV, No. 2. Evidently this climatic change, resulting in vegetational instability, was comparatively well-marked in eastern and southern South Island, and one hopes that further studies into its nature and results will be undertaken, especially in Central Otago where soil anomalies point to the same developments. It has had practical consequences in that European occupance developed at a time of vegetation instability and this has served to emphasise the erosional consequences of practices which, even under favourable conditions, tend to lead to soil despoliation.

The third part of the paper deals with the impact of exotic animals on the forest. 'The acclimatisation of deer, pigs, goats, wapiti, chamois, thar, rabbits and other animals has initiated a fresh series of changes, so that over and above the readjustments now in progress as a consequence of past climatic instability are superimposed changes due to the incidence of grazing and browsing in the complete absence of normal predator control.' The net result is for the forest canopy to be destroyed and for heath, fern and scrubland to take its place. The removal of the watershed forests is potentially the most serious feature and may have devastating and widespread consequences. The forests are needed not only for timber but for water conservation. 'Upon the delimitation of suitable management areas and upon the devising of suitable silvicultural techniques, depends the greater part of the country's future hardwood supplies. Upon the conservation of the *Nothofagus* forests of the mountains in the face of the threat of browsing animals, depends the control of all major rivers and the preservation of all our hydro-electric resources.'

The alarming picture of the steady incursion of erosion and browsing animals into an unstable forest canopy of inherent peculiarities should not go unheeded. Mr. Holloway has stated a case for further investigation and action with all modesty and due scientific caution. His conclusions deserve very careful study and whether or not disaster occurs he is to be congratulated on his statement and his warning.

—B. J. Garnier.

2. *In Overseas Journals . . .*

The Chorological Approach to Agriculture

THE AGRICULTURAL REGIONS OF NEW ZEALAND: Kenneth B. Cumberland, *Geographical Journal*, Vol. CXII, Nos. 1-3, July-September 1948, pp. 43-63.

Dr. Cumberland states that his paper is an attempt to bridge a serious gap in New Zealand's geographical literature by delimiting and describing the distinctive agricultural regions of the dominion. The regions have been based on the work of Derwent Whittlesey who has provided a classification of world agricultural regions. Whittlesey has listed five 'functioning forms' that characterise the agriculture in any area, these being: (1) the crop and livestock association; (2) the methods used to grow the crops and produce the livestock; (3) the intensity of application of labour, capital and organisation, and the output of products which results; (4) the disposal of products for consumption, whether used for subsistence on the farm or sold for cash or goods; (5) the collection of structures used to house and facilitate the farming operations.

After observing the New Zealand landscape over a period of years and testing these observations by a detailed study and analysis of all official statistical data available, Dr. Cumberland divides the dominion into the following four generic agricultural units; whilst the high and broken land of both North and South Island he classes as non-agricultural land.

(a) Livestock Ranching—which includes broadly the districts of inland Wanganui and Taranaki, Hawkes Bay, Poverty Bay, Nelson, Marlborough, inland Canterbury, Central Otago and Banks Peninsula.

(b) Commercial Dairy Farming—embracing the districts of North Auckland, Coromandel Peninsula, Bay of Plenty, Waikato and Hauraki Lowlands, Taranaki, Manawatu and Horowhenua.

(c) Commercial Livestock and Crop Farming—which includes the Canterbury Plains and Downlands, Eastern Otago and the Southland Plains.

(d) Less important farming regions which comprise the Volcanic Plateau and the lower portions and valleys of Westland.

The author realises that as descriptive names Whittlesey's terms—'Livestock Ranching','Commercial Dairy Farming' and 'Commercial Livestock and Crop Farming'—do not reflect very exactly the crop and livestock associations typical of New Zealand's pastoral farming. The pastoral industry may be broadly divided into enterprises situated mainly on hilly and mountainous land which produce wool and store and breeding sheep and cattle, and enterprises on flat and rolling land which produce milk and meat. On the former enterprises the pastures consist of native or sown pastures in which clovers are absent or relatively unimportant, whilst the pastures of the latter are rich in clovers. It is this clover-grass association which gives the pastures the protein-rich herbage which is so essential for milk and meat production. Such pastures are a rather unique feature of New Zealand farming and few other pastoral areas are capable of producing meat and milk from pasture alone. In all the four subdivisions of the Commercial Dairy Farming Region (even after allowance is made for dairy cow replacement stock) sheep and cattle for meat production are quite an important feature of the livestock association. The term 'intensive pastoral farming' possibly describes the livestock association of these areas which produce meat and milk more clearly than 'commercial dairy farming'. North Auckland-Coromandel and Manawatu-Horowhenua are mixed livestock areas rather than dominantly dairying regions, for both contain fairly large areas devoted to extensive pastoral farming.

Dr. Cumberland's paper is worthy of close study both by geographers and agriculturists and is an excellent basis for a further discussion of the subject.

—P. W. Smallfield.

REVIEWS

Pioneer Geographer and Explorer

WILLIAM COLENSO; PRINTER, MISSIONARY, BOTANIST, EXPLORER, POLITICIAN: HIS LIFE AND JOURNEYS. By A. G. Bagnall and G. C. Petersen. Wellington: A. H. and A. W. Reed, 1948, pp. 494.

Authors, publishers and the New Zealand State Literary Fund (by which the venture is subsidised) have rendered a signal service to New Zealand history by making available this record of the life of one of the most remarkable figures in early New Zealand. Colenso's life in New Zealand falls readily into three more or less clearly distinguishable periods. First was that of the very early years of colonisation when he graduated from printer for the Church Missionary Society to accredited Missionary Deacon of the Church of England, with his base of operations first at Paihia and then at Ahuriri on the then desolate coast of Hawkes Bay. This period culminated in the revocation of his licence as Deacon in November 1852 for a moral lapse that any ordinary man could easily have concealed. But Colenso was no ordinary man. His honesty was fanatical and uncompromising.

The second period was one of his rehabilitation as a layman in Hawkes Bay society—a period covering the ten or fifteen years after 1852. This was the period when he gave thought to the accumulation of a personal estate which was modest by comparison with what he could have had earlier had he not set his face so uncompromisingly against acquiring land from the Maori. This was the period of his various ventures into politics, both provincial and national. His political life was not a success for he was not the stuff of which successful politicians are made.

The third period, dating from around 1870 till his death in Napier on 10 February 1899, in his 89th year, was one of relative calm after storm. In 1872 at an age when most ordinary men would be thinking of retiring he took the post of inspector of schools in Hawkes Bay. This is of some special interest because in striving for the recognition of school studies in natural science he had a profound influence on elementary education, an influence that was further promoted by his friend Henry Hill who succeeded him in this important office. Elected to a Fellowship of the Royal Society in recognition of his lifelong contributions to science, and restored to priestly office in the church that had cast him out in 1852, he lived his last years in Napier honoured of all men. Focus of his interests in Napier over these last years was the Hawkes Bay Philosophical Institute which he last addressed as president in 1896.

Especially of the earlier part of this full and active life the book gives an adequate account from which emerges a picture of Colenso as a man of prodigious energy and endurance, insatiable in his curiosity as a collector and classifier of plants, facile with the Maori tongue and fanatical in his zeal for both the spiritual and material welfare of the Maori people. The reader with special interest in historical geography looking for description of the primitive New Zealand landscape before the wholesale destruction of the forest cover may well be disappointed, for the account of Colenso's remarkable journeys throughout the North Island is often reduced to a recital of routes so bare as often to be tedious. But Colenso seems to have been interested mainly in the species composition of the primitive plant cover and most of his published scientific work, which the present authors would comb for information, was

concerned with classification. His New Zealand Exhibition essay 'On the Geographic and Economic Botany of the North Island of New Zealand' (*Trans. & Proc. N.Z. Inst.*, Vol. I, 1868) well displays the fact that his primary interest was in the species comprising the plant cover.

Nevertheless the authors have done their country a service in recording the life and times of one of the most colourful of its early citizens. His personal life and character are depicted with fairness and sympathetic understanding, and incidentally the reader will find much of interest on many such aspects of New Zealand history as the influence of the missionaries on the primitive Maori people, and on many such vigorous early colonists as Williams, Selwyn and Maclean. The work is adequately documented and indexed so that the serious reader will have little difficulty in finding his way to the significant source material. It is unfortunate, however, that most of the maps have been so reduced in reproduction as to be barely legible.—G. JOBBERNS.

THE MAORI GEOGRAPHY OF THE WELLINGTON COAST

HOROWHENUA: ITS MAORI PLACE-NAMES AND THEIR TOPOGRAPHIC AND HISTORICAL BACKGROUND. By G. Leslie Adkin. Wellington: Department of Internal Affairs, 1948. pp. 446.

Although Mr. Adkin's title should sufficiently indicate the scope and subject matter of this book, his treatment is so much better than anything of this type yet produced in New Zealand that it is scarcely fair to have to mention *Horowhenua* in the same breath as the usual study of Maori place-names. If we regard his place-names from the accuracy of their orthography, the acquaintance with the Maori language they reveal, and the wealth and interest of the traditional history they illuminate, only Andersen's *Maori Place-Names* can compare. Beyond this aspect *Horowhenua* has few if any parallels, so that the task of describing it is rather like conveying the characteristics of a new species or genus of publication on Maori history.

The author takes that confined region of historic Maori earth on the southwest littoral of the North Island, appropriately defined by the lake which dominates it, which the author well terms the 'centre and soul' of the district. To the west the area is bounded by the twenty-mile coastal dune belt reaching from the Otaki River to the Manawatu; to the east it is bounded by the Tararua Range, which confines the narrow coastal plain. On this vast plane-table he plots in by words and maps, and so accurately that one feels it can never be improved, every physiographic feature recognised and named by the Maori, and every arbitrary mark which as men they made on nature. These include features as evanescent as the old Maori trails, or the clearings made for refuge or as places of cultivation in a now vanished bush, as meticulous as the twenty-odd canoe landings scattered round the margin of the lake's 900 acres, and the twenty-three named eel weirs following its Hokio outlet to the sea. In addition Mr. Adkin draws in the tribal boundaries, ancient and modern, the sites of permanent villages, forts, cultivations; everything, in short, which a passion for recording accurate traditional history, and a keen interest in archaeology, can add to his fundamental interest as a geologist and farmer in the topography and physiography of the area.

The author's treatment of the artifacts found in the area, particularly in the dune-belt and from the mud bed of Horowhenua, sets a new standard in the clarity of the

text descriptions and the admirably clear line drawings. One feels he should be employed by a benevolent State to extend such happy 'rural rides' in archaeology to other regions of the North Island. His isolation of an older series of middens in the coastal dunes, thirty to a hundred chains from the fore dune, whereas the later middens average less than twenty, provides for the first time an approach to a geological time scale in the history of man in New Zealand. In the burials the evidence for a moa-hunter culture stratum is well-founded on adze and ornament types. Mr. Adkin does not however succeed in establishing a primary association of moa and human remains at any point, and the coincidence of a flint knife and moa crop stones (see p. 80) on a Tararua peak is hardly convincing. Another slight blemish in the discussion of the moa-hunters is a tendency to trace them as a specific tribe (quite reasonably called Waitaha) but pressing on in one purposive migration from North Auckland to the South Island, and leaving en route such footprints as the 'lintel' of Kaitaia, the Whangamumu chevroned pendant, the middens of Waingongoro, and the Horowhenua dune burials.

Among random topics, the descriptions of the artificial island pa of Horowhenua, and of the artificial canals (whakamate) for trapping eels are of particular interest. The latter are so well understood and described that Mr. Adkin might well claim their first description.

A great part of the text is taken up with the alphabetic listing of place-names, involving in their interpretation many valuable incursions into tribal history and geology. The author pins their origin to fancies as pleasing as the resemblance to the white curve of an albatross' breast (Kopu-toroa), to human breasts moulded in earth (Nga-u-papa), to the wing of the extinct eagle (Pakau-hokio), as lively as an infestation of grasshoppers (Te Kai-a-te-Kowhitiwhiti), or as mundane as the water where one, Whiripo, washed (Wai-horoi-o-Whiripo).

As is axiomatic with a publication from the Historical Branch of the Department of Internal Affairs, the production and format leave nothing to be desired. The Polynesian Society has taken over the distribution of the book as their Memoir No. 26.—ROGER DUFF.

THE FAR NORTH

THE GUMDIGGER. By A. H. Reed. Wellington: A. H. and A. W. Reed, 1948, pp. 168.

Mr. A. H. Reed has already written many popular records of New Zealand history and geography. His new book is probably the most interesting and valuable he has yet produced. Called quite simply *The Gumdigger*, it provides a complete history of the gumdigging industry and the men who made it. Such a story could have been presented as an impersonal thesis, and as such, would have had considerable interest, as the race of gumdiggers has all but passed away. But what gives Mr. Reed's book its special charm is its intensely personal tone, in the sound old tradition of Maning, and the robust honesty and humanity of its author.

Mr. Reed was himself a gumdigger in the last decade of the nineteenth century. His father arrived in New Zealand in 1887; times were bad so the whole family went to the northern fields seeking kauri gum. It was a hard struggle, but gum put the

family on its feet, and in the realms of art and literature, the Reeds have since become a very well-known New Zealand family.

And so, in 1947, in his seventy-second year, Mr. A. H. Reed, filled with nostalgia for the early days, returned to the northern fields. There, on lonely Mt. Camel, on the Houhora Harbour, 220 miles north of Auckland, he camped alone in a musterer's hut and found that he could still earn his 'tucker' by digging gum. The early part of the book in which this grand old man describes his return to the scenes of his youth, is delightful in its unaffectedness and in its feeling for place and people.

Later, Mr. Reed tells the story of kauri gum, which played such a large part in our early history. By about 1905, 10,000 tons were gathered in a year at £60 a ton, making it one of New Zealand's biggest industries, and employing up to 7,000 men. Today less than 300 gather gum. Mr. Reed describes all the digging methods, and tells stories of the cosmopolitan horde of diggers, French, Dalmatian, Finnish, Cockney, Norwegian and others, which provide material, as he says, for many a novel.

He moved to the farthest north, still chasing gum, to Te Hapua, the northernmost settlement, and Reinga lighthouse, stopping at lonely homesteads, visiting deserted *pa*. He met the descendants of some of the early northern settlers; he tells us the history of such colourful pioneers as Sophie Subritzski, the Polish emigrant, and Samuel Yates, 'the King of the North'.

The Gumdigger has many illustrations, chiefly pen-and-ink sketches, and maps; more interesting, still, is a unique series of photographs showing diggers and their methods in earliest times. This very instructive book has a distinctive flavour; it speaks on every page of a deep love of New Zealand, a sincere interest in her history, a nostalgia for the past, and a sensitivity to human values and to natural beauty.

—J. C. Reid

The Future Population of Australia

POPULATION TRENDS AND POLICIES. By W. D. Borrie. Sydney: Australasian Publishing Co., 1948, pp. 264.

Thoughtful people in Australia and New Zealand must inevitably be interested in the problem of population because of the inadequate numbers of people in these countries relative to the natural resources available. That the total population of Australia and New Zealand together is somewhat less than half the annual increase in world population and that there is sufficient arable land in the world to support only three-quarters of the world's present population at Australasian living standards as far as foodstuffs is concerned, must cause us to think seriously and constructively about the population problem.

Any book, therefore, which assists in disseminating accurate information about the population problem as it affects the white races or any work which adds to the understanding of this important problem, deserves a wide reading public. *Population Trends and Policies* which has as its subtitle, *A Study in Australian and World Demography*, deserves therefore careful reading by students of this great social problem. The first part is devoted to an excellent survey of population trends, first in the West, then in the East. The remainder of the book, in four parts, deals with trends of population growth in Australia, and the penultimate chapter on population trends and

international relations is a sane yet challenging survey of the need for some hard constructive thinking about the future. The author shows that the Western peoples have almost reached a period of stability in their population growth with a tendency even to decline, and that in spite of the various means which have been developed in many countries in an attempt to stem the downward curve in population growth, doubtful success has been achieved. He points out that so many factors are militating against the large family group in Western society that it is practically impossible to encourage people again to have large families. Nevertheless, he does suggest that certain cash benefits could be extended or introduced, but he fails to explain satisfactorily how these will encourage the young people of today to have larger families.

Some good arguments are marshalled to illustrate that there is no real hope of increasing Australia's population quickly to a figure commensurate with what she could carry in relation to her natural resources, but there follows the rather naive suggestion that Australia will have to take a realistic view of her position in international affairs. The author shows that there are dangers in the so-called 'expansionist policy', that is, the policy of increasing population quickly by immigration and a high birth rate, but unfortunately advances no new solutions or suggestions which will assist those endeavouring to increase Australia's population by all legitimate means. Moreover, some statements made are inclined to leave one puzzled, such as the suggestion that there is an opportunity to take resources to people instead of taking people to resources.

New Zealand readers will note that the author erroneously refers to the Social Security charge as a five percent deduction from salaries and wages instead of the fifteen percent it actually is. As the work is liberally illustrated with statistics, many of which relate to countries other than Australia, this error makes one inclined to wonder whether the text has been checked as carefully as it might be. Another unfortunate circumstance is that the legibility of many pages has been adversely affected because the type on the reverse side shows through.

The virtues of the book, however, far outweigh its shortcomings. It should assist materially towards tightening up some loose thinking upon many aspects of the population problem by placing them in their proper perspective. In many ways it is an excellent survey and brings many statistics of world and Australian population up to date.—H. I. Sinclair.

Crossroads of the Pacific

HAWAII: A HISTORY. By Ralph S. Kuykendall and A. Love Day. New York: Prentice-Hall, Inc., 1948, pp. 321.

Hawaii: A History is a notable, opportune work. The main purpose of the book is to give a chronologic narrative of the Hawaiian Islands showing their transformation and cultural evolution from 'a group of primitive subtropical islands into a modern centre of agricultural industry and international trade'. The secondary aim is to put forward the claim of statehood for Hawaii.

The historical account, which appears to be largely a revised and modernised version of Kuykendall's earlier *A History of Hawaii*, is divided into six books. The first gives a very brief insight into the political, economic and social life of 'prehaole'

Hawaii up to 1779. The second deals with the conquest and subsequent unification of four kingdoms into a single monarchy. This coincided with the initial external economic impetus when the islands were utilised as a port of call by vessels engaged in the fur trade with China. By 1819, however, the islands were taking on the aspects of a racial melting-pot, and there followed an epoch in which the whaler and the missionary were greatly to influence the economic, religious and social life of the kingdom. Whaling constituted the basis of the islands' prosperity for many years, but sugar cane and some wheat and potatoes were grown to supply the demand created in California by the discovery of gold.

The third book covers the period from 1854 to 1874 during which 'there was a marked swing away from American missionary influence toward a closer relationship with England . . . . . [and] . . . . . from American democratic ideals'. During this period, Hawaii shifted to a more solid economic foundation; from whaling to sugar cultivation and grazing. The fourth and fifth books discuss the sequence of events leading to the annexation of Hawaii by the United States. The reciprocity treaty of 1876, which completely welded the economy of Hawaii to that of the United States, could be easily singled out as the most noteworthy occurrence during the last quarter of the nineteenth century. The sixth book, covering the period from 1900 onwards, brings the history to date. The record of the territory during this half century is an enviable one. The application of mechanised and scientific research to the pineapple and sugar industry has made Hawaii a capable, leading producer of these two commodities. A modern educational system, patterned after the United States model, has produced an identical product, even in polyracial Hawaii. The war record of the islands is unsurpassed by any other state or territory of the U.S.A. and it is apparent that Hawaii has met the requirements for statehood.

To accomplish their secondary purpose, the authors point out that Hawaii has proved herself economically, patriotically, politically and culturally and that the blessings and benefits of statehood are long overdue. Such a union would be reciprocally advantageous.

The authors deserve congratulations for their comprehensive bibliography, which suggests a thoroughness in dealing with source material not usually to be had in most popular historical accounts. A further indication of the completeness of the work is the appendices, which comprise a wealth of pertinent data.

The major criticism, from a geographer's point of view, is that the chronologic human drama is presented with only a very brief introductory reference to the geographic setting. Perhaps the history of the islands is in itself of sufficient interest to merit its portrayal in a geographic vacuum, but the inclusion of a more detailed description of the geographic background would add immeasurably to the appeal of the work. Moreover, the presentation of material would have been greatly enhanced by a series of historical maps. An attractive place map confronts the reader upon turning the cover, but it is cartographically inadequate. Pleasing as it may be to the eye, it still lacks such essential features as latitude, longitude, scale and many place names appearing in the text. The lack of an appropriate accurate map or maps is somewhat compensated by two excellent pictorial sections which illustrate many of the essential aspects of Hawaiian economy, culture and physical background.

—A. W. Smith.

Towns and Cities

URBAN GEOGRAPHY. By Griffith Taylor. London: Methuen, 1949, pp. 434.

There is a singular lack of textbooks in English on urban geography. Students will welcome therefore the recent statement by Professor Griffith Taylor. Dr. Taylor is well known for his previous publications in the field of geography as protagonist of the environmentalistic concept. In his latest book, *Urban Geography*, he is as forceful as ever in support of his contention that 'the peculiar province of the geographer is to interpret the relation between man and his environment'. Not all students of geography will be in agreement with this viewpoint and, as a result, will find much to criticise as the author develops his thesis still once again.

Urban Geography is divided into three parts. The first describes representative settlements in each of the seven continents as an introduction to an analysis of the principles involved in the selection of urban sites and the development of urban patterns. The second part of the book is a review of the historical development of towns from primitive times through to the modern city. The final section is a classification of towns on the basis of the dominant feature of their respective physical environments, for example, as river towns, fall-line towns, seaports, and mountain towns. Throughout the book the author has confined his observations largely to a study of site, history, and street pattern. Where descriptions of functional areas are made in addition to the factors listed above, the value of the studies is increased greatly, but there is a comparative lack of such descriptions.

The 190 maps and diagrams are sketched in the distinctive style one associates with the work of Professor Taylor. There is one photograph. A bibliography is included of approximately 172 publications, in addition to references given in the text. *Urban Geography* will probably be of most use as a work of reference rather than as a textbook for the student of urban geography.—L. L. Pownall.

The North American Tundra

BOTANY OF THE CANADIAN EASTERN ARCTIC. PART III: VEGETATION AND ECOLOGY. By N. Polunin. Ottawa: Department of Mines and Resources, 1948, pp. 304.

The appearance of the third part of this impressive series completes the story of the arctic vegetation. The first part, *Pteridophyta and Spermatophyta*, was published in 1940, and the second, *Thallophyta and Bryophyta*, in 1946. A promised further part will deal with the subarctic regions. Together the three volumes represent not only the most important contribution made to our knowledge of the botany of the Canadian Arctic but they also represent an outstanding addition to the relatively few complete works dealing with the detailed phytogeography of a major region. Professor Polunin has made the Canadian Arctic his own particular province, and in the third volume he summarises his information and gives a picture of the Canadian Arctic regions commencing with the northern part of Ellesmere Land and working south to northern Quebec and Hudson Bay. Throughout the account one can trace the gradual enrichment of the flora as the climatic conditions ameliorate with passage southwards.

The Canadian Eastern Arctic is divided by the author into ten major districts because he is convinced that there is such great variability from place to place that at

the moment it is not possible to establish final botanical districts. Professor Polunin points out that the vegetation of the southern part was even less known than that of the northern and it is evident that he has done much towards eliminating the anomaly. For convenience in comparison the description of the ten districts is treated in the same manner. This has the disadvantage of forcing the reader to turn from page to page if he is interested in a particular type of vegetation, but it has other compensations.

The botanical and phytogeographical world owe a great debt to Professor Polunin for these contributions and it is to be hoped that they may spur other investigators to complete the picture in the Arctic of Western Canada and of Alaska. To students of the geography of North America the *Botany of the Canadian Eastern Arctic* will be of great interest also, and will constitute a source of precise information long awaited.

—V. J. Chapman

A Textbook of Geomorphology

LANDSCAPE AS DEVELOPED BY THE PROCESSES OF NORMAL EROSION. By C. A. Cotton. Christchurch: Whitcombe and Tombs Ltd., 1948, pp. 509.

This book, first published in 1941 by Cambridge University Press has been considerably enlarged, in part rewritten, and printed as a second edition in New Zealand. With *Climatic Accidents in Landscape Making* and *Volcanoes as Landscape Forms* it completes a trilogy which must surely rank as the standard exposition of the subject matter of geomorphology. W.M.Davis, the pioneer and acknowledged master in this field, never compiled any such complete systematic statement, and almost thirty years ago, in 1922, Professor Cotton firmly established his place in this branch of earth science with his *Geomorphology of New Zealand, Part I, Systematic*. Reissued in 1926, this was out of print within a decade, its place as a summary of the elements of the subject being taken by his *Geomorphology* published in 1940.

In the volume under review the field of geological literature relating to evolution of landforms is combed for pertinent illustration of an orderly, methodical survey of the processes of normal erosion. Serious students of the subject should find his discussion of peneplains (Chapter XVI) and his brief but penetrating comments on the theories of Penck of especial interest. The author displays throughout the trilogy a remarkable clarity of thought and precision of statement and a mind hospitable to any useful idea that may present itself. This is scientific exposition in the best tradition and one cannot escape a feeling that in New Zealand Professor Cotton has been hardly adequately recognised as an authority and example in this wider field. This reviewer considers *Landscape* to be the best of Professor Cotton's trilogy and regards its statement of the cycle of erosion to be without equal in any language.

The publishers are to be congratulated on a very fine example of what New Zealand can do in the way of book production.—G. Jobberns.

Geography in Maps

GENERAL CARTOGRAPHY. By E. Raisz. New York: McGraw-Hill Book Company, Inc., 1948, pp. 354.

The ability to construct simple but effective maps and diagrams is one of the fundamental requirements of the geography student, and the publication of Dr. Raisz'

General Cartography in 1938 was particularly appreciated by geographers because it was concerned primarily with the technique of representing geographic data in map or diagram form as distinct from the complementary science of surveying. A second edition was published in 1948, and most of the chapters have been painstakingly revised to incorporate, in Dr. Raisz' lucid style, explanations of new cartographic methods and devices evolved during the last ten years. In addition, new chapters outlining the principles of surveying on the ground and from the air have been included 'because a cartographer needs to know a great deal about surveying methods if for no other reason than to understand their limitations . . . [and] . . . the subject as it is treated here represents the minimum amount of knowledge that a geographer should have'.

General Cartography is divided into two parts. The first deals with the history, compilation, drawing and printing of maps in a most readable and practical manner and is supplemented with a wealth of diagrams. The three chapters on map projections have been expanded. They aim to explain the properties and uses of the different kinds of graticule rather than to expound at length the intricacies of their computation, but the constructional features of most are illustrated by a series of ingeniously devised diagrams, which are, almost literally, self-explanatory.

Dr. Raisz' effective landform maps showing surface relief and vegetation by appropriate pictorial symbols have become familiar to readers of modern American texts, and his latest chart of symbols will be studied with interest. Landform maps present an easily visualised small-scale picture of the relief of a region without the need of expensive colour printing, but their limitations are apparent in the representation of fairly flat areas and it seems misleading to fill in plains which would otherwise be blank with vegetation symbols and to omit vegetation from the closely symbolised mountainous regions.

The second part of the book—Special Cartography—opens with four new chapters. The first begins with the simpler methods of field surveying—compass traverses, plane-tabling and levelling—which lie within the capabilities of the college student of geography, for whom this chapter was explicitly written, and concludes with the principles of major triangulation and precise levelling. Within the limits of thirteen pages the scope of surveying is admirably summarised and the intention is clearly to explain professional surveying to the student rather than to dwell upon simple methods of drawing maps in the field. New chapters follow explaining clearly, and as simply as this now complex science will allow, the methods employed in aerial surveying and the interpretation of vertical air photographs, and the very practical suggestions will be especially valuable to geographers.

The remainder of the second part deals with sea and air charts and with a wide selection of maps and diagrams which may be used to illustrate specialised geographic information, and this is the most fascinating part of the book. Dr. Raisz has combed a great variety of sources for illustrations, from the cartogram on the Budapest trolleybus ticket to the climatograph used in crop forecasting. The chapter dealing with cartography in wartime makes interesting reading, too, and indicates the nature of some of the mapping problems which arose with the spread of war to poorly mapped areas.

This second edition is, therefore, a substantial development of its predecessor.

Dr. Raisz has obviously been at great pains to include the latest information on every aspect of his subject, and as one who writes with authority on matters cartographic his new volume is one which will be valued by geographers and all others whose interests lie with maps.

The larger format of the book has enabled more information to be packed into fewer pages, the new type faces used are pleasing and though many diagrams have been reduced slightly in size from the first edition, both they and the many additional diagrams are well reproduced.—R. H. GREENWOOD.

AN AMERICAN TEXTBOOK OF GEOGRAPHY

COLLEGE GEOGRAPHY. By Earl C. Case and Daniel R. Bergsmark. New York: John Wiley and Sons, 1949, pp. 790.

As in its earlier editions this excellent textbook is both a regional geography of the world and an economic geography. Its outstanding feature is the masterful organisation of a huge selection of geographic facts and principles into a simple and effective pattern. The first part lays a foundation in physical geography; the second treats human activities on a framework of climatic regions; and the third and fourth parts deal with minerals and trade respectively.

The revision of the third edition has been completed by Dr. Case following the death of Professor Bergsmark in 1945. New diagrams, charts and maps have been added and the subject matter has been revised to interpret the world in the light of conditions since the second world war. Perhaps the most significant addition is a complete chapter on 'Tropical and Semi-Tropical Islands of the Pacific'. Its inclusion in this world geography is another important step toward the too long delayed recognition of the Pacific. Similarly it has taken a world war to prompt a more detailed treatment of U.S.S.R., the Orient, western Europe and the Arctic rim.

The problem of revising all the production facts and statistics in such a comprehensive work as this can be appreciated. Nevertheless readers in New Zealand will wonder at the statement (on page 400) concerning the forest industries of New Zealand. 'The average annual cut of saw timber is about 500,000,000 board feet, primarily kauri and white pine.' It is unfortunate that this and some other statements in the book are based on out of date sources.

College Geography is a commendable introductory text in geography on the university level. Its language is simple and concise, it is well-illustrated, and its organisation makes it a handy reference volume.—H. J. CRITCHFIELD.

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